Bell Telephone

Events of Great Magnitude in Our Business
LEROY A. WILSON

Some Observations on Industrial Research
OLIVER E. BUCKLEY

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LEWIS M. FUEHRER AND GLEN WHITEMAN

Adventure in Telezonia • LEROY A. BORN

XUM

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Spring 1950

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A Medium of Suggestion & a Record of Progress

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LEROY A. WILSON, *President;* CARROLL O. BICKELHAUPT, *Sec.;* DONALD R. BELCHER, *Treas.*

XUM

Who's Who & What's What

in This Issue

PRESIDENT LEROY A. WILSON'S notable statement to stockholders at the American Telephone and Telegraph Company annual meeting, which heads this issue, is the third since he took office on February 18, 1948. His election to the presidency of A. T. & T. followed by some 26 years the start of his Bell System career in the Indiana Bell Telephone Company. Two days after graduation from Rose Polytechnic Institute in Terre Haute, Indiana, in June of 1922, he reported for work as a traffic clerk and student in Indianapolis. For some years with that company he had direct charge of the telephone operating forces in several districts throughout the state before returning to Indianapolis as district traffic superintendent in 1927. Mr. Wilson transferred in 1929 to the Department of Operation and Engineering of the A. T. & T. Company in New York. His first work there was in the Traffic division, but he also gained experience in dial equipment engineering and in related fields. Ten years after his arrival in New York, he moved from the Traffic to the Commercial division of O. & E., where he was placed in charge of the work on telephone directories. The following year he was made rate engineer in the same division, and in 1942 he was appointed to head the entire Commercial division. It was from this post that Mr. Wilson was promoted to an A. T. & T. vice presidency in 1944, with the assignment to study the revenue requirements of the Bell System; and it was during this period that he contributed "Reasonable Earnings to Insure the Best Service" to the MAGAZINE for Autumn 1945. His statements to stockholders at the last two annual meetings have appeared in these pages, as has his "A Look Around—and Ahead," which was published here last Autumn.

THE TALK WHICH OLIVER E. BUCKLEY gave before the American Patent Law Association in Washington earlier this

Leroy A. Wilson

Oliver E. Buckley

W. M. Marsters

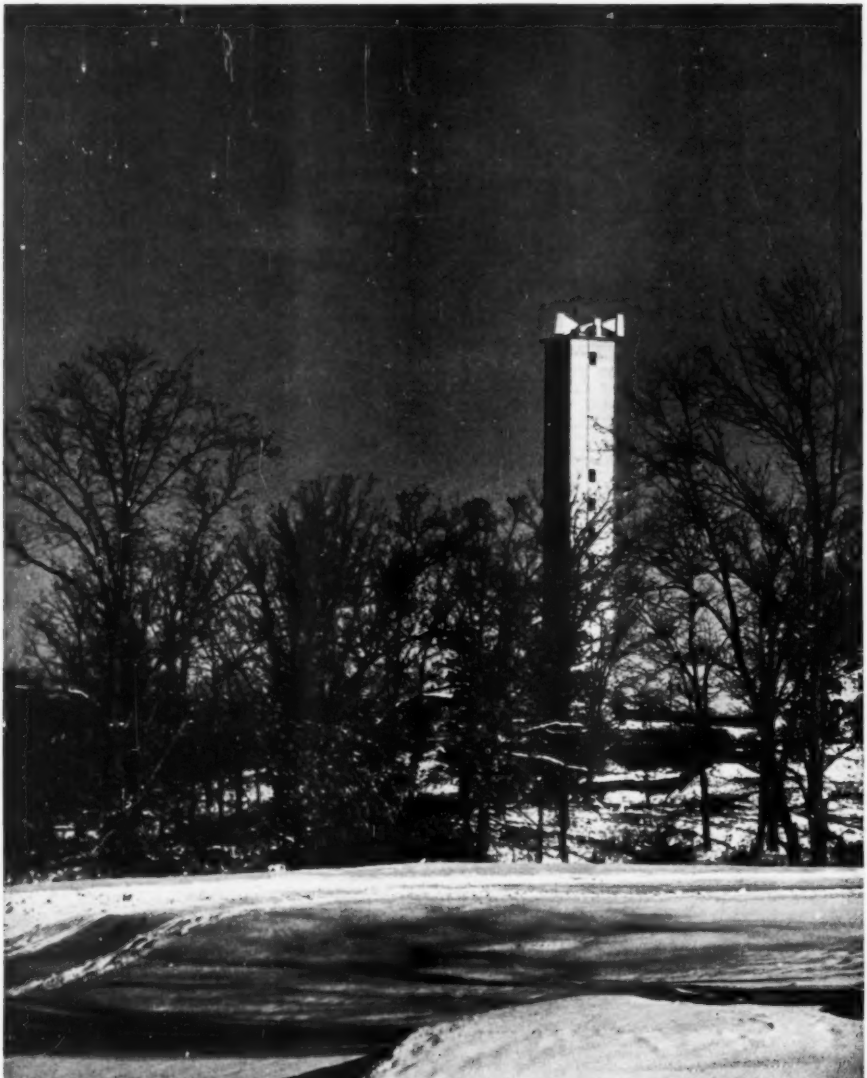
Lewis M. Fuehrer

Glen Whiteman

year was a description of selected research, inventive, and developmental activities of the Bell Telephone Laboratories. Such an exposition of scientific progress in terms of but three products inevitably reveals also something of the philosophy which motivates the work of the Laboratories, and is doubly interesting for that reason. Dr. Buckley entered the Bell System in 1914 as a research physicist. In 1927 he became assistant director of research of the Laboratories, and was made director of research in 1933. He became executive vice president three years later, and in 1940 became President of the Laboratories. During the first World War, commissioned as Major in the Signal Corps, he had charge of the Research Section of that Service in Paris. During the second World War, in addition to heading the Bell Telephone Laboratories, which made incalculable contributions to the victory of the Allied Nations, he was a member of the Communication and Guided Missiles divisions of the National Defense Research Committee. He is serving as a member of the National Inventors' Council and of the General Advisory Committee of the Atomic Energy Commission. Dr. Buckley is a fellow of several scientific and engineering societies, and is a member of the National Academy of Sciences and the American Philosophical Society. He contributed "Bell Laboratories in the War" to the Winter 1944–45 issue of this MAGAZINE, and took part in a symposium on "The Bell System's Progress in Television Networks" which was published in the Autumn 1946 issue.

THE BELL SYSTEM career of W. M. MARSTERS began with the New England Telephone and Telegraph Company in Portland, Maine, in 1910, and the ensuing 40 years have seen but two major interruptions: the first while he completed his studies, graduating in 1914; and the second, during World War I, while he served in the Office of the Chief Signal Officer, A.E.F. With Western Electric for a short time in 1914, he was one of the original telephone repeater men on the first transcontinental route, before transferring to the Long Lines Department the following year. When he returned from the Army, in 1919, he was assigned to equipment engineering work associated with the rapidly developing carrier-operated toll systems and with dial central offices. For thirty years and more his activities have expanded from that point, and he has been involved in

(*Continued on page 66*)



A new feature on the American landscape: one of the radio relay stations of the Long Lines Department of the American Telephone and Telegraph Company. This one is near Valparaiso, Ind. ***See the article beginning on page 25***

In His Statement at the Annual Meeting of Stockholders Of A. T. & T., the Company's President Points Out the Post-War Gains and the Problems Which Lie Ahead

Events of Great Magnitude In Our Business

Leroy A. Wilson

IN THE last five years events of great magnitude and importance in our business have been taking place with remarkable speed. While all of them may be more or less familiar to most of you, I think a brief review will be helpful in making their significance more clear.

First is the tremendous post-war demand for telephone service. During these five years, the number of Bell System telephones has increased almost as much as in the first half-century of the telephone's existence.

To meet this gigantic demand, the System has been strenuously engaged in what is by far the biggest construction program in its history and the largest peace-time program of any private enterprise.

To build all the facilities needed and handle the ever larger volume of service, there has been a substantial increase in telephone employment.

At the same time, there have been steep rises in wages and also in the cost of materials. These have affected us in two ways:

First, the cost of construction per telephone has gone up so that the new plant we have had to build—and are still building—is a lot more expensive than plant built years ago. These new facilities represent nearly half of the Bell System's total plant investment today.

Second, the higher wage and material costs have likewise greatly increased the day-to-day expense of rendering telephone service.

Thus we have had to meet the problem of earning a return on a much more costly plant at the very time when expenses were going up faster than income.

Meanwhile, in order to build the facilities needed to give the service that people want, we have had to obtain a tremendous amount of new capital—more than 3½ billion dol-

lars since the war ended. Conditions have made it necessary to obtain most of this new money by selling debt obligations. As a result, the proportion of debt in the System's total capital has gone up from less than one-third to slightly more than one-half.

All these developments have come almost on each other's heels. And the rise in costs has made necessary a further development of utmost importance—the upward repricing of telephone service. Here we are still catching up. A great deal has been done, and the recent improvement in earnings is encouraging. Our responsibility, however, is not merely to meet immediate needs but to insure the long-range financial stability of the System. I want to say a little more about that in a moment.

ON THE service side the Bell System people have done wonders. More than 12 million telephones have been added and the waiting list reduced to a very small proportion—about two percent—of all telephones in service. Over-all service quality is now the best ever—fast, clear, dependable, and courteous. In short, the telephone today serves more people and serves them generally better than at any time in the past.

However, we still have important service problems. While it is true that we are now meeting the great majority of requests for telephones promptly, our objective is to give service without delay to all who ask for it, and we want to meet that objective fully. Again, there are many people today on four-party lines who would like two-party service, and many more who would like to be on individual lines as soon as we can build the necessary facilities. Everyone who wants a higher grade of service than he now has ought to be accommodated, and I am glad to say that we are making steady progress in that direction.

Also during this eventful post-war period, new services, new and improved equipment, and better and more economical operating methods have been introduced and continue to come into wider use. Steady improvement of equipment and methods is essential to keep on increasing the quality of service and to keep the cost as low as possible. Technical improvements alone, however, will not today insure the long-range financial security of the Bell System. The rise in the cost of doing business has been so steep that increases in telephone rates have been and are essential. In the last ten years or so, wages alone have gone up nearly twice as much as rates, and to meet the problem additional increases in rates will be necessary.

TWO THINGS seem clear. One is that we shall continue to need additional capital to give the service the public wants. The other is that the proportion of debt in the System's total capital should be substantially reduced from the present level of about 50 percent. If we had entered the post-war period with the present proportion of debt, it is difficult to see how we could have met service demands as we have. We should be equally well prepared for any contingencies in the future.

It follows, therefore, that most of the new money required should come from issuing stock, either

through conversion of debentures or otherwise. It likewise follows that earnings must be adequate to make the Company's stock attractive to new owners, and that these earnings continue to be sufficient, as additional shares are issued, to insure a stable return and protect the investment of existing stockholders and new stockholders as well. This is the foundation of everything we are trying to do, and it is just as important to telephone customers and employees as it is to the stockholders—for investors' money is essential to give customers the service they want, good service is essential to win customers and thereby maintain good jobs for employees, and good earnings are essential to attract and protect the savings of investors.

In stressing the importance of a stable return, I am aware that I have not touched on the decline in the real value of the dollars in which the return has been paid over a period of many years. This problem exists throughout our whole economy, and is most certainly a matter for grave concern. Its solution, if there is to be one, must I think depend on economic forces affecting the entire nation. But in the meantime, when the dollars of our dividend buy less, we must be doubly sure that the stockholder gets at least the full number of dollars.

A word about taxes: We think the telephone is paying more than its fair share. For the average Bell System telephone, the total tax load is over $2 a month. More than half of this amount is in excise taxes applied at very high rates. I know of no other service of like necessity that bears a comparable burden.

AS ALREADY MENTIONED, wage increases in the Bell Telephone Companies in the last ten years total about twice as much annually as the increases authorized in telephone rates. It is also a fact that present wages average about double what they were ten years ago. Bell System wage policy is to pay wages that compare favorably with those paid for similar skills by other concerns in the communities where the Bell Companies operate. To do less would assuredly be bad for telephone serv-

President Leroy A. Wilson extended cordial greetings to many stockholders at the annual meeting of the American Telephone and Telegraph Company held on April 19, 1950

A display of many items of communication equipment had been set up in a room adjoining the assembly room in which the annual meeting took place, and was a point of interest to numbers of stockholders

ice, for in order to give good service it is necessary to attract and keep competent people. On the other hand, payment of unduly high wages would be unfair to telephone customers who pay the bill.

Telephone wages have gone up much faster than the cost of living during the war and post-war period. There are other factors in telephone employment, too, that are extremely advantageous. The Bell Companies have been pioneers and are leaders today in their Benefit and Pension Plans. Telephone work is generally steady work, and this is an up-from-the-ranks business with unusual opportunities for advancement. In fact, for every five employees in the Telephone Companies, there are more than two promotions to better jobs at higher pay in an average five-year period.

Present contracts between the various Companies and the unions provide for higher wage payments in the coming year for the large majority of all non-management employees. Nevertheless, many of the unions have made heavy additional demands, and the leaders of the Communications Workers of America (CIO), whose divisions represent about half of all employees of Bell Companies who are represented by unions, have threatened a strike on April 25 unless agreements satisfactory to them are reached.

I hardly need to say that the Companies concerned are intent on doing everything they properly can to avoid any interruption of telephone

Teletypewriter service in operation—"the written word by telephone"—was a feature of the display. Here it is being explained to A. T. & T. Directors James F. Bell and Vannevar Bush

service. They are also keenly aware that they should be fair not only to their employees but equally fair to telephone users who pay the bill. The importance of this becomes all the more clear when it is remembered that further wage increases would immediately call for additional rate increases beyond those already authorized and pending, and also beyond those which must still be applied for to meet past rises in costs.

The Companies have carefully checked their wages with the wages paid by others in the areas they serve, and have found that telephone wages and over-all working conditions compare extremely well with outside industry. The Companies have also asked the unions to present factual data in support of their further demands, but little has been forthcoming in that respect.

I wish I could tell you what the outcome will be, but only time will tell. I am however sure of these things:

First, as the President of one of the Associated Companies recently expressed it, "The Company wants good pay and good working conditions for its employees. Our management has no incentive to pay less than other employers for the skills necessary to furnish our high quality of service."

Second, the Companies feel an obligation not to pay wages that would place an undue burden on telephone users.

Third, the managements in all the Companies engaged in bargaining,

who came up from the ranks themselves, will be zealous in maintaining wages and working conditions that are fair to all concerned.

IN CONCLUSION, I have one further thought that I would like to leave with you. Clearly we have had a great many serious and difficult problems to meet in the last few years, and there is no doubt that the same will be true in the future. These problems are of all kinds—service problems, technical problems, expense problems, wage problems, rate problems, employment problems, financing problems, and almost every other kind of problem that can be imagined. The success of the business depends on meeting every single one of these problems and meeting all of them wisely and well. Nothing less will do. It goes without saying that this demands the utmost acceptance of responsibility by management, complete devotion to the best interests of the business as a whole, and the capacity and willingness to exercise leadership no matter what obstacles must be overcome. This is true today in our business just as it is true in every other phase of our national life.

It seems to me, therefore, that there is one other problem even more important than those I have just mentioned. That is to find, develop, and hold the future leaders who can be depended on to manage this business well and guide it to greater achievement in the years that lie ahead. This is an absolutely essential part of your present management's obligation to carry this enterprise firmly forward. It is the key to success in the long run, for no business succeeds without good management and good management does not just happen. It has to be selected, developed, and encouraged. Nothing will help more—nothing will better serve to attract the leaders we shall need in the future—than the encouragement and support that you stockholders give to management efforts.

So I urge you to make that kind of contribution to the future of your business. I assure you that it can and will give incentive and inspiration to those on whom you must depend to manage the business well not just today and tomorrow but for years and years to come. And I assure you also that by so doing, you as stockholders can each take a personal part in making more valuable to this nation the essential service rendered by the Bell System.

Index Now Available

AN INDEX to Volume XXVIII (1949) of the BELL TELEPHONE MAGAZINE may be obtained without charge upon request to the Information Department, American Telephone and Telegraph Company, 195 Broadway, New York 7, N. Y.

Mindful of Its Responsibility

An announcement on the "Telephone Hour" radio program of January 30, 1950

VERY OFTEN on this program we have talked about the responsibility the Bell System has for providing an ever-improving telephone service to the people of America.

We have also spoken of the responsibility that management has for paying a fair return on the investments of the hundreds of thousands of people whose savings have built our telephone system.

Our business also has a responsibility to the employees, and tonight we'd like to tell you a little about that part of our job. First, the business must pay good wages, wages that compare favorably with those paid others in the community for comparable skill and experience. Holidays and vacations should be provided for, as well as sickness benefits and pensions on retirement.

Merit should be recognized and opportunity provided for advancement, and there must be the kind of satisfaction with the job that comes from good working conditions, thorough training and knowledge of the business. The record shows that telephone people enjoy all these things to a high degree. They have steady year-round employment. They are among the best paid industrial groups in the nation.

Recent U. S. Department of Labor reports show that telephone line construction, installation and maintenance employees rank ninth among more than 200 separate industries. These reports also show that the girls on the switchboard are well above the average of the white collar workers with whom they compare.

Telephone Company employees are protected by a well-rounded benefit and pension plan. It helps them in meeting emergencies that may come with sickness, injury or death. It provides for both service and disability pensions. The Company pays all the costs.

One of the reasons the Bell Telephone System has been able to meet its responsibility to the users of the service and to the investors is that it has been mindful of it responsibility to those who spend their working lives in the business. All this adds up to why your telephone service is better today in most respects than ever before and will keep right on improving in the future.

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The Forward March of Service

Excerpts from President Leroy A. Wilson's New Year's message to the members of the Bell Telephone Laboratories form an appropriate introduction to the address by the head of those Laboratories which begins on the opposite page. EDITOR.

TELEPHONE SERVICE begins with technology, and continuously through the years it has been the widening of technical horizons that has made possible the expansion and improvement of the service. The greater the range and usefulness of the service, the more extensive and intricate our technical knowledge and physical equipment have first had to be. But I would emphasize that although technology must come before the service, the service *idea* comes before the technology . . .

As we approach the mid-point of the Twentieth Century it is interesting to look back and see how telephone science and telephone service have advanced hand in hand in the years since the century began. To recall just a few of many outstanding developments within this period, we may think of the telephone repeater and the establishment of transcontinental service; the advance in radiotelephony and the creation of worldwide overseas service; the inauguration and development of fast, accurate dial service, with more than 70 percent of all Bell telephones now on a dial basis; and the origination and extension of carrier telephony, making possible the economical handling of vast numbers of toll and long distance calls.

Coming down to more recent years . . . new toll switching systems have opened up the field for long distance dialing, both by operators and by telephone users, and direct nationwide dialing in the years ahead will help to revolutionize our conception of how good telephone service can be. Broad band radio relay and coaxial systems, already carrying television images as well as telephone conversations, provide the means for transmitting intelligence on an entirely new scale. Automatic message accounting makes a tremendous contribution to service both in the direct dialing of telephone connections and on the accounting side. New instruments, new materials in outside plant, new tools for construction and maintenance—all are aimed at . . . the rendering of the best and most economical telephone service to the American people that it is possible for us to provide. . . . The needs and opportunities are very large—not only in the long-term future, but also in the years immediately before us. I am confident that telephone science, animated as it always has been by the service idea, will continue to enable us to make telephone communication always better, more extensive, and more valuable tomorrow than it is today. And I am confident also that in Bell Telephone Laboratories we shall continue to have the people, the skills, the organization and above all the inspiration to accomplish that end.

The Interrelation of Research, Invention, and Development In the Work of the Bell Telephone Laboratories Is Here Discussed by Their President

Some Observations on Industrial Research

Oliver E. Buckley

[*An address before the American Patent Law Association in Washington, D. C., March 6, 1950*]

IN A BRIEF TALK on the broad subject of industrial research, it is obviously impossible to be comprehensive. I have therefore chosen a title that would give me considerable latitude, and in discussing industrial research I shall limit myself to only a few of its many aspects. My own enthusiasm for the subject is not based primarily on generalities but on particularities, so I have elected to discuss a few specific developments to which research has contributed significantly and in different ways, and in which invention has played an important part.

From a great number of research products on which we have worked in Bell Laboratories, I have selected only three: the telephone receiver, electron tubes for microwave radio, and a newly invented device called the transistor.

Research on the telephone receiver dates back to Alexander Graham Bell, and has been continuous since the birth of telephony.

Microwave radio is of later development, and only in recent years has it been put to practical use.

The transistor is in its infancy, but has a promising future.

All three subjects represent a diversity in other and obvious respects. They are, however, alike in being very important in attaining the high quality and low cost that is one of the major objectives of telephone research. In the work that has been carried on in these three developments, moreover, there are certain features common to all of them that I should like to point out later.

The Telephone Receiver

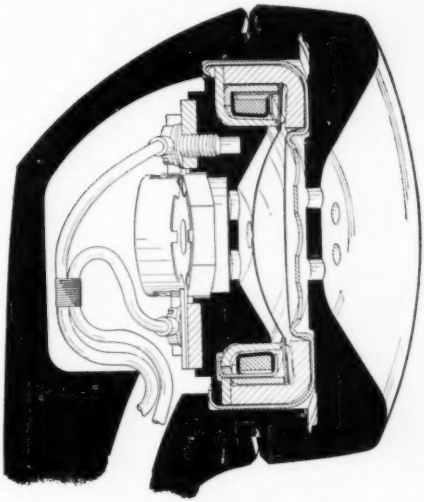
THE telephone receiver is a small and simple device. In fundamental principle, the receiver that forms part of the telephone on your desk today is like that devised by Mr. Bell within the first year of telephone history—and a remarkable year of achievement that was. Over the course of the years, other principles have been incorporated as advances have been made, not steadily but in jumps, and the most radical advance in all the seventy-five years of telephone receiver history has been incorporated in the latest design of telephone instrument just recently announced.

Looking back over those years of telephone receiver development following Bell's original telephone, we see that they break into two epochs: in the first, design changes were made by applying the best thought of engineers and designers to improving the performance of a device without departing from accepted fundamental principles; and in the second, all such restrictions were thrown aside, and an investigation was launched to find, for purposes of research, how a receiver might be designed to achieve perfection of performance independently of its cost or its suitability for practical use. Only by achieving actual perfection in a laboratory model

Left: Early telephones, shown at the top in perspective view of 75 years of telephone development, had no separate listening device: mouth and ear were applied alternately to a combined transmitter-receiver. The new receiver discussed in the adjoining columns is part of the latest type of telephone, now on trial, which is pictured at the bottom of the illustration

could we get a sound measure of practical compromise between cost and performance in the commercial product.

This undertaking was begun about 1915. The essentially perfect performance sought was achieved in the late 1920's. We built in the laboratory a system which would convey speech from one person to another as effectively as if one spoke directly to the other close by. This system then served as a reference for judging the performance of commercial telephone apparatus. Since then we have been driving at narrowing the difference between the practically achievable product of the factory and the ideal of perfection toward which we strive. We have made great gains, as all of you know. These gains have come out of organized research along several lines, two of which I want especially to describe.



A perspective cross-section of the new receiver, showing the ring-type coil and the dome diaphragm

RIGHT AFTER the first World War, we undertook research on submarine telegraph cables which led to enhanced interest in magnetic materials of high initial permeability to make feasible the inductive loading of ocean cables and thus an improvement in telegraph speed. A nickel-iron alloy had been discovered and a heat treatment devised which led to a solution of this problem. Other uses for such alloys were sought and found, and a greatly expanded investigation of magnetic alloys was undertaken. Fundamental understanding of the process of magnetization was lacking, and so we endeavored to find out why a combination of nickel and iron was so much better than either of them alone.

At the same time, we pursued a cut-and-try procedure and mixed up hundreds of combinations of nickel, iron, cobalt, and other elements, and subjected them to a variety of heat treatments. Early returns came from this strictly empirical type of research, as often happens.

We are still working on the fundamental research which at first trailed the cut-and-try method but later pointed the way to further improvement.

As magnetic research went on, new materials were developed with ever better properties: materials, for example, that were a hundred times easier to magnetize than is iron, and others very hard to de-magnetize that made excellent permanent magnets. Out of this work came materials designed to have qualities especially desirable for many applications in our business; among them was the telephone receiver. Three different al-

loys were developed to meet the special needs of this instrument—a nickel-iron alloy for the pole-pieces, an iron-cobalt-vanadium alloy for the diaphragm, and an iron-cobalt-molybdenum alloy for the permanent magnet. These alloys make possible light weight and high efficiency, and they also have mechanical properties suitable for economical manufacture.

ANOTHER line of research also contributed to this development. Again it relates to inductive loading, for it was his method of solving the problem of loading telephone lines that led Dr. George Campbell to invent the electric wave filter,* so important in all communication engineering today. A whole new technology of alternating current network analysis grew out of the original work on the filter, and in the course of time engineers began to apply this analysis to mechanical systems. A telephone receiver could thus be regarded as an electric wave filter made partly of electrical, partly of mechanical, and partly of acoustical elements, and an electrical network could be made to simulate its action. Indeed, the telephone receiver of earlier times was a wave filter that left room for improvement. Its resonant diaphragm made it much louder at certain frequencies than at others, and was responsible for its distortion of speech sounds.

To get rid of this distortion, it was necessary to insert resistance in a manner calculated to make the receiver pass all frequencies alike. This was accomplished by devising a chamber within the receiver so that air is pumped in and out of an orifice as the diaphragm vibrates. At the same time, the air in this chamber adds other elements of mass and stiffness, and thus the equivalent network becomes more complex. Indeed the air cavity between the receiver and the ear of the user plays a measurable part in performance. It is, however, all capable of calculation if exact measurements of the properties of individual elements are at hand. It was on this basis that the present standard telephone receiver was designed. Its high efficiency and light weight have been made possible by improved magnetic materials, and its low distortion by analytical design based on precise measurement.

We are not satisfied with it, however, and have found a way to make even a better one, which is incorporated in the newest model telephone instruments now undergoing trial. In this new receiver, a lighter diaphragm made of a flat ring carrying an impregnated fiber dome gives better coupling with the air. A ring-shaped coil, and ring-shaped magnet and pole-piece, actuate the diaphragm. The whole structure is both lighter and more efficient than its predecessor.

ONE FURTHER FACTOR figured significantly in its development. To achieve our ends, it was necessary to develop new methods of rapid and precise measurement. A whole new art of acoustical measurement has been achieved over the past thirty years, and this new art has led to advances in other fields as well.

The telephone receiver which has evolved is not, of course, a single in-

* An electric circuit capable of passing or rejecting groups of frequencies at the will of the designer.

vention but has drawn upon many inventions in materials and in structures. Systematic research in magnetics, acoustics, and electrical networks gave a foundation in knowledge and understanding. Precise measurement gave a basis for systematic design. A well defined goal gave an objective. Ideas for achieving that goal came out of the minds of inventors. Research and invention had to be followed by development to give a reliable, reproducible, long-lived device that could be made economically and to precise specifications. Thus were combined the knowledge and skills of physicists, chemists, metallurgists, mathematicians, and engineers. Among them were inventors who were bold in questioning whether the others were on the right track, and in proposing new ways to reach the goal.

Thus the course of research to improve telephone receivers is marked by development of new materials, the application of analytical methods, the transfer of a method of thought from one art to another, the use of rapid and precise measurement, and—most of all—by setting a well defined goal of perfection.

Electron Tubes for Microwave Radio

THE FIELD of microwave radio transmission is another in which measurement techniques and analytical procedures have figured prominently.

The advance of radio communication has been marked by the extension of the usable radio spectrum to higher and higher frequencies, and as the frequency limit has been pushed up, new problems of ever increasing difficulty have been encountered. New tools of measurement have had to be devised for every step.

These tools were our first undertaking when in 1930 we began working in the hitherto unexploited region of thousands of megacycles. We were interested in the application of those frequencies both to radio relay systems which we then envisioned and for transmission through pipes or wave guides.

The soundness of that approach has been demonstrated by the great advances which have followed, but its importance proved far greater than anyone could have anticipated, for these tools of measurement were at hand and proved invaluable when the war came along and microwave radar was developed. Without those tools, some of the great accomplishments of radar could not have been achieved in as short time as they were.

The utilization of very high frequencies for communication has been dependent in great degree on the availability of amplifiers. The ordinary vacuum tube amplifier, such as is used in the radio broadcast art, starts falling off in amplifying efficiency at frequencies well below 100 megacycles per second. Two factors are principally responsible: one, extra capacitance * between electrodes of the tube; and the other, the time required for electrons to travel from the negative to the positive electrode of the tube.

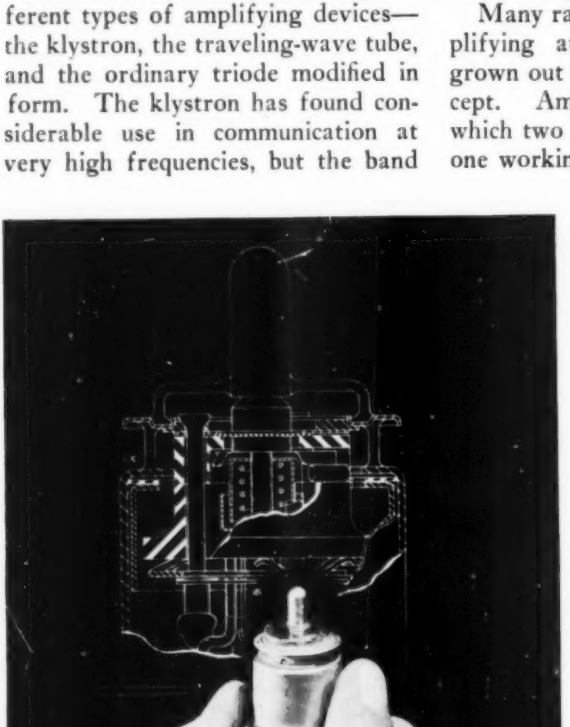
To overcome these obstacles has been an objective in almost every research group in this highly competi-

* One of the factors that affects the amount of current that will flow in a circuit.

tive field. As research has added to understanding, and as invention has produced new devices for getting around obstacles, the frequency range available for communication has been pushed to the region of billions of cycles where formerly it was limited to millions.

Figuring prominently in this advance have been three essentially different types of amplifying devices—the klystron, the traveling-wave tube, and the ordinary triode modified in form. The klystron has found considerable use in communication at very high frequencies, but the band width of frequencies it can amplify is limited by resonance effects. The traveling-wave tube provides an escape from this limitation, and the highest frequency at which currents have been amplified to date has been reached with a traveling-wave tube working at 48,000 megacycles—with waves only a quarter of an inch long. We can expect it to go even higher.

Many radical new schemes for amplifying at high frequencies have grown out of the traveling-wave concept. Among them are tubes in which two electron streams are used, one working on the other, and tubes which combine the features of the traveling-wave tube with those of the magnetron used for generating radar pulses. Indeed, this is an area of research that is probably unsurpassed in activity, and inventions are appearing from many parts of the world.



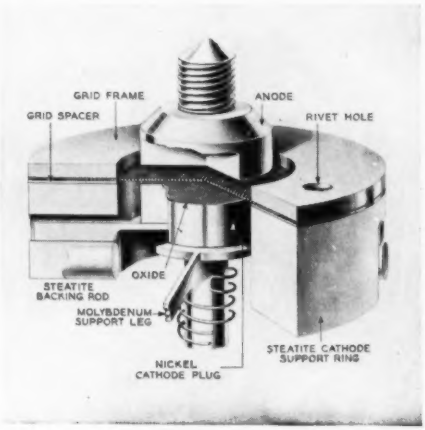
A close-spaced triode tube is shown against an enlarged cross-section drawing of it

It is, however, about the simplest type of electron tube, the triode, that I want principally to talk, both because of its simplicity and because it illustrates the contribution of persistent research and clever inventiveness to improving the capabilities of an existing device by going to extremes without introducing new fundamental principles of operation.

This little tube, about the size of an English walnut, is at the heart of the repeater used in new radio relay systems, such as that now being installed between New York and Chicago. Small as it is, this tube can handle enough power to send a beam of radio waves from one tower to the next, usually about thirty miles away. Better yet, it can handle a broad band of frequencies, so that the beam can carry many hundreds of telephone channels and television as well.

A tube for a radio relay system that is to span the continent has to be a very reliable device, for a hundred relay stations, each using a number of tubes, must work in tandem, and the failure of only one tube may cause an interruption. Further, even the very small distortion that may occur in a single amplifier can build up into serious distortion in a long succession of amplifiers. These were some of the considerations that led to developing the simple triode into a device to work at frequencies above 4000 megacycles.

Though having the same fundamental elements as the original de Forest audion—a filament, grid, and plate—this tube is radically different in structure and shape. The electron-emitting filament has become a flat surface ground to great precision. That surface has been coated with materials to facilitate release of electrons in number far greater than was once thought possible.* This makes it possible to get the power output we need, and at the same time retain a small area and correspondingly small capacitance between electrodes.



Here is a cut-away drawing showing the active elements of the close-spaced triode tube

The grid is still a structure of wires stretched in a plane, but what different wires they are! Unless your eyes are better than mine, you could not see them without a magnifying glass. They are only three ten-thousandths of an inch in diameter—about a fifth the diameter of a fine human hair—and are held in place with a precision consistent with that size. The spacing between grid and cathode is only six ten-thousandths of an inch, and it must remain closely fixed as the tube is heated and cooled. The anode,† or plate, has become part of a resonant cavity to reduce capacitance effects, and its dimensions are as accurately held as are other parts of the tube.

Indeed, this tube has a precision unapproached by its predecessors and, for that matter, equalled by few mechanical devices. It would be wrong, however, to assume that this

* In this tube, we get nearly two-tenths of an ampere of electrons per square centimeter.

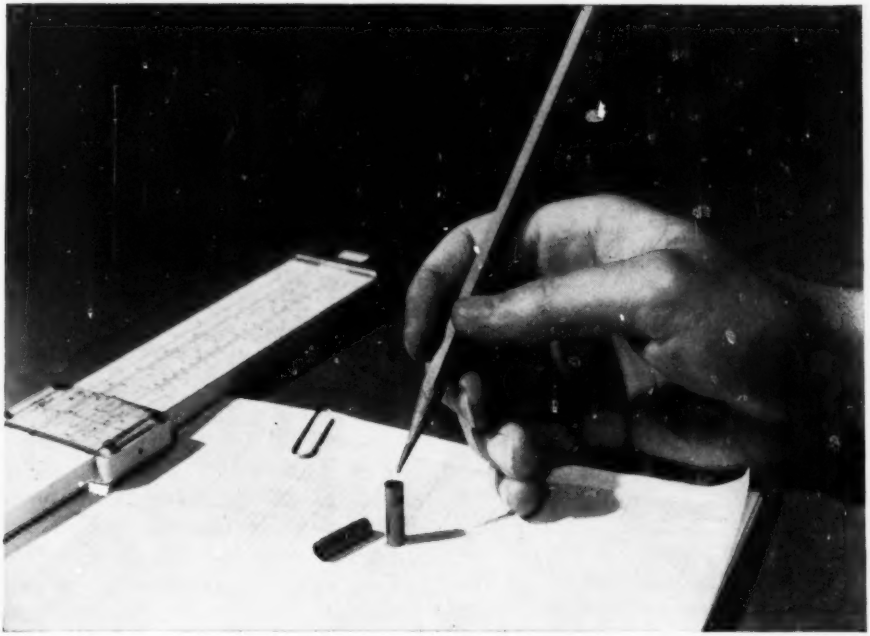
† The anode is the positive electrode of a tube, while the cathode is the negative electrode.

One of the air-conditioned rooms at the Bell Telephone Laboratories where parts of the close-spaced triode tube used in radio relay systems were assembled during the development period

was an instance of straightforward engineering that anyone skilled in the art of vacuum tube design and construction could do. To achieve the result which this seemingly simple device represents, there has been applied knowledge growing out of years of research in wave guides, network theory, thermionics, electron dynamics, and even theory of quality control. Added to this essential theoretical background were the products of research in metals, ceramics, soldering compounds, glass-to-metal bonds, and the chemistry of getting the surfaces of these materials atomically clean. New inventions had to be forthcoming to make it possible to build the tube. A new method of making coated cathodes had to be devised, a special machine had to be invented to wind the grid with the required uniformity, a new ceramic seal had to be invented, as did also an entirely new method of assembly. These steps were not the obvious ones to take, but came from original ideas, from invention, and from the capacity for taking infinite pains.

A New Device: the Transistor

MY THIRD and last topic is the transistor. It is a device for amplifying electric currents, and so is a competitor of the amplifying vacuum tube, but, unlike it, has no vacuum, nor does it have a hot cathode. In structure it



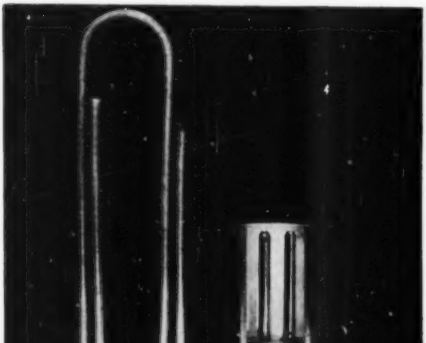
Two of the transistors which are currently under development at the Bell Laboratories as amplifying devices

is a very simple thing, consisting only of a tiny germanium crystal with a couple of metallic points close together pressing on it. Current through one point to the crystal influences current through the other point from the crystal.

The transistor is such a simple device that one may well wonder why it was not discovered by cut-and-try experiments. Many experimenters had had the idea that a solid-state amplifier should be a practical possibility, but all of their attempts to make one had failed. It was not for lack of trying that such an amplifier was not invented earlier, but for lack of understanding.

The transistor is as much a product of invention as was the vacuum tube amplifier; but in the absence of knowledge of just what goes on at the contact of a metal point with the surface of a semi-conductor, no one had the basis for conceiving how to make an amplifier from a germanium crystal with a couple of metallic points pressing on it. It was to get an understanding, and with a confidence that something useful would come out of it, that a systematic research on the properties of semi-conductors was organized.

Semi-conductors are those materials in the solid state intermediate in conductivity between metals and insulators. Silicon and germanium are two such materials. We had a spe-



Set beside an ordinary paper clip, this sectionalized transistor reveals its diminutive size

cial interest in them because of applications we were making of these materials in certain control devices and in rectifiers for very high frequencies.

ONE OF THE characteristics of germanium, and also of silicon, is that it may exist in either of two states depending on the presence of minute impurities. In one of these states a metallic point in contact with it will pass current in one direction but not the other, and in the second state the direction of rectification is reversed. This oddity is explained by those who understand solid-state conduction as due in one case to conduction of electricity by a slight excess of free electrons, which conduct electricity in the same manner as free electrons in metals, and in the other case to conduction by the transfer of holes where electrons might be but are not because of a deficiency of supply.

On purely theoretical grounds, there was reason to believe that such a material might have its conductivity altered by subjecting it to an electric field. This theory suggested one way in which a solid-state amplifier might be made. An attempt was made to build such an amplifier, but since it did not work, an explanation was sought. Suspicion was directed at the extreme outer layer of the material, which is a region not so well understood as the interior. Various experiments were devised to modify surface effects. These included experiments to find the effect of light and also of contact with various metals and electrolytes, not just by cut-and-try but in an endeavor to analyze the surface state and to determine the conditions for transfer of electrons and holes along the surface and to the interior.

IN THE COURSE of these systematic experiments, it was discovered that the resistance to the flow of electrons from a metallic point to a germanium crystal could be modified by applying voltage between the crystal and a drop of electrolyte placed on it close to the contact point. This result, together with other experiments, fitted into a theory consistent with the accepted theory of solid-state conduction by holes and electrons. The properties of an amplifier based on this control action were found to be limited by the characteristics of the electrolyte. Intelligent speculations and experiments were carried out to devise methods to avoid the use of the electrolyte. This led to the in-

vention of the transistor, which operates on a different basic principle from any anticipated when the work was started.

BY PLACING two points close together on a crystal of germanium, the surface of which had been carefully prepared, and by sending current through one of them in one direction, the resistance of the other is modified for current in the opposite direction. It is said by the theoreticians that the concentration of electrons in the region close to the first contact, both on the surface and in depth, is modified, and as a result the electrical characteristic of the nearby contact is modified. Thus the circuit through one point contact acts something like the grid-to-filament circuit of a vacuum tube, and that through the other, something like the filament-to-plate circuit—though this is not in fact a very sound analogy.

As I said earlier, the transistor is still in its infancy, and although several applications of it have been made in the laboratory and many possible uses have been demonstrated, it should not be expected to replace vacuum tubes generally. For many purposes it may be used as vacuum tubes are, but an even larger field of use may well be found where vacuum tubes cannot serve. The facts that no filament current and no warm-up time are required make it particularly attractive as a control device.

Out of the original transistor have already come a great variety of ideas for modifications and for applications. Meanwhile, the device is gradually being perfected into the rugged and reproducible unit that it must be for commercial use. In time, men, and money, this is, as usual, the big end of the job.

Progress in Industrial Research and Development

THE THREE DEVELOPMENTS I have touched upon represent three of many ways of making progress in industrial research and development. I might have chosen any of numerous projects of comparable importance and found as many other patterns of action. There is no standard pattern, but there are some things in common for these three that apply to many others.

All of them are based on sound physical understanding and precise measurement. All represent pursuit of goals very difficult to achieve. None represents blind groping in the dark, yet none represents blind adherence to existing methods or designs. All were directed at securing the highest possible quality at the lowest possible cost, for that is our business; but all were directed also at improving our understanding of the things we work with, for that is our business too. All were the products of teamwork, drawing from the knowledge and skill of many workers of different talents. In each instance, mathematics, physics, chemistry, and engineering all played a prominent part. All drew from a broad background of scientific knowledge, and at the same time from an intimate acquaintance with communication technology and communication needs.

Important inventions were conceived by the workers on all three projects—but these inventions were not group products. They did not come automatically because an able group was put to work on a difficult

problem. They arose just as inventions have always arisen, from the minds of imaginative men.

There was, in my opinion, just as much genius in these inventions as in inventions in the simpler areas of technology of earlier days. The technology of today is more complex, and deeper digging is required to unearth new ideas, but the ideas so unearthed still are a product of the mind. Inventions represent discernment of relationships that only become obvious after they are pointed out. They usually require overwhelming interest in and intense application to a specialized field.

The makers of these inventions to which I have referred worked in a favorable atmosphere for their inventive effort. They were exposed to new knowledge as it was unfolded by group attack on basic problems. They were provided with good tools of measurement. They were in a position to see practical needs. They had not only economic incentive, but also the satisfaction of contributing to advance toward an ideal.

It has been our experience that invention is not an automatic result of engaging in systematic research and development. This is indicated strikingly by the distribution of inventions among the individuals who participate. Actually, only about four percent of them make half of all the inventions. It is easy to recognize the characteristics we have come to associate with inventiveness in those who are most prolific. Those who invent most are engineers or scientists who are not content to admit that anything is impossible. They delight in upsetting the pattern, and are more willing to try experiments that do not make sense in terms of accepted laws and traditions, but do make sense to their own intuition as to how things might work. They are usually idealists, yet they are practical, for they want to achieve useful results. They are apt to be sensitive. They are more interested in controlling the behavior of physical things than in managing other people. When an inventor becomes an executive, he usualy ceases to be an inventor.

The technical work of the modern industrial research laboratory is done by scientists and engineers ranging in character from the very methodical to the highly imaginative, and in occupation from the most fundamental research to detailed development for commercial manufacture and use. Some among these workers are outstanding inventors. With good surroundings and good tools, all are enabled to work effectively; with a sustained program of research, they have the benefit of accumulated knowledge special to the field in which they work; with well-defined objectives, they work effectively toward worthwhile ends; and with a common high ideal, they work together cheerfully with enthusiasm and zeal.

Concrete and Steel Structures of Various Forms and Sizes Are Springing Up on the Landscape to Speed Voices and Television Programs Across the Land

Radio Relay and Other Special Buildings

W. M. Marsters

RECENTLY an official of the Long Lines Department of the American Telephone and Telegraph Company was returning to New York by plane. As he approached the city, the young lady sitting in the adjoining seat, who had been looking out the window, said, "I wonder what that monument is down there."

The telephone man looked out and, recognizing the structure, said, "That, young lady, is a monument to telephone progress."

It was the Buckingham Mountain radio relay station, near the eastern border of Pennsylvania, and probably one of the best examples of the progress which has taken place in the years since Alexander Graham Bell spoke those famous words on his crude telephone in that Boston attic. And from where the young lady sat, looking down, the structure probably had the appearance of a monumental shaft rising from a cleared space on a wooded hilltop. If she could have seen it from the ground nearby, on the other hand, she might perhaps have noted its general resemblance to a tall lighthouse, which also transmits beams—but of light.

Most of the others of the total of 31 that have been erected on the New York–Chicago radio relay route, however, are truly monuments in their general design, and from high in the air might very well look like the famous Bok Tower in Florida—without the latter's decorative features. Unlike the Bok Tower, however, which was erected to please the esthetic sense and house the famous carillon, the radio relay buildings were erected for a strictly utilitarian purpose: to house the radio relay equipment and to place the antennas high enough in the air to do their job properly.

Radio relay is a term designating a microwave radio system designed to carry signals from one point to another point by relaying them at

intermediate stations. The waves are projected in a straight line, like the beam from a searchlight (in fact, they are very much like light waves in many respects), and they do not follow the curvature of the earth like, say, broadcasting waves.

Incidentally, radio relay stations do not march overland in a straight line, but proceed slightly zig-zag fashion. This is to prevent possible interference if a transmitted wave should overshoot its intended mark, the adjacent station, and be received at an antenna farther along the route.

The radio waves are not seriously affected by haze, rain, or smoke: things which would prevent you and me from seeing between stations. There must, however, be an actual line-of-sight path between each two adjacent stations. So, to reach from one end of a radio circuit to the other, the originating station must see the first repeater (relay) point, that one must see the next one, and so on until the receiving terminal station is reached. In laying out a route, one of the clear-weather tests often made to see if there is an unobstructed view between two possible station sites is to flash a high-powered spotlight at one point and ascertain whether spotters at the second point can see the flashes.

To get the waves started out in the proper direction, the antennas employed are of the directional type, each accurately pointed toward a similar receiving antenna located at the next station. These antennas must be mounted on structures of sufficient height so that intervening trees, hills, or other obstructions will not hinder the radio waves as they travel from station to station. The antenna-supporting structures must be rigid enough so that a high wind will not cause enough deflection in the direction the antennas are pointed to affect transmission.

Routes and Sites

SELECTION of location for radio relay stations presents problems fundamentally different from those for the location of structures required on open-wire or cable routes.

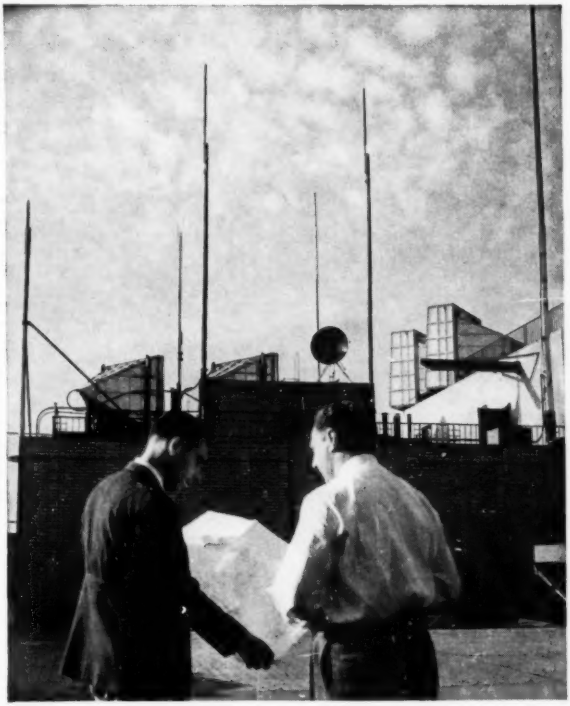
On these last, the all-important object is to construct the open-wire line or cable over the route which will be the best from the standpoint of ease and economy of construction and future maintenance, and of safety of the outside plant. Once the route has been selected with these considerations in mind, the buildings required along it must be located as required from a transmission standpoint, using the tolerances permitted in the spacing to keep the structures out of low spots where they might be flooded and as near roads as practical so that they will be accessible for maintenance. It may be said, indeed, that the location of buildings on open wire lines or cables depends almost entirely on the selection of the outside plant route. On radio relay systems, there is no physical plant along which buildings would be placed at some prescribed interval, so the method of determining where the intermediate relay points should be located is considerably different.

Let us consider what is involved in laying out a route between New York and Chicago by the way of Philadelphia, Pittsburgh, and Cleveland. That is just the general direc-

tion. There will, of course, be intermediate points—Harrisburg, Johnstown, and Akron, perhaps—which some day, if not now, will require connection with the relay system for telephone or television service. So the route selection must also take into consideration plans for getting into such cities either directly along its path or off the main route and reached by the use of side legs.

This background sets up the general outline of the route. From here, the detailed job of actual lay-out starts. With a rough outline of the route, and general guides of procedure, what is the next step? Maps: the latest topographical if available; but, if these are not available, which is the case for some sections of the country, just maps—road maps, county maps, any maps which might give help. Topographical maps are of course the most useful, as they show not only roads and streams but also the height of the land—since, in general, it is desirable to get the stations as high up in the air as necessary to obtain clear paths over longer distances.

By the use of these maps, tentative routes are plotted on paper and field work is then undertaken. This consists of a complete coverage of the route, checking the heights of selected station sites and intermediate high points by instrument measurement and finding out such things as whether land is available, the amount of road construction required at the various tentative sites, the distance to power lines, and like matters. This requires a great amount of good old-fashioned work: traveling as far as one can by car and then climbing the hills by shanks mare over roads or trails if they exist—but get up there anyway!



What happened to the roof of one telephone building when radio came along! On the top of the Long Lines headquarters building in New York are visible the New York–Boston and New York–Chicago radio relay antennas, antennas for mobile and other services, and—at upper right—a corner of the radio-relay equipment penthouse

One of the seven hilltop radio relay stations along the route between New York and Boston. This location is Jackie Jones Mountain, near Haverstraw, N. Y.

—so that the entire route has been looked over and checked and the best station sites have been noted. The work then returns to the office and detailed route maps of the different possibilities are prepared for study from transmission, cost, and other standpoints. As a result of these studies, the route is selected. There then remain the details of obtaining the properties for the stations and making final transmission tests to insure that the paths between sites will be satisfactory.

The job of obtaining the sites is turned over to the legal people, who usually obtain an option on the properties first so that transmission measurements may be made. To make these measurements, light-weight sectional towers are erected at two adjacent stations, radio waves of the frequencies to be used are transmitted from one station to the other with the antennas located at different heights on the towers, and readings are made of the received currents. From these readings it can be determined whether the transmission path is satisfactory and also the height of the structures which are required. When all these factors prove to be satisfactory, the land is purchased and the building man is ready to go to work.

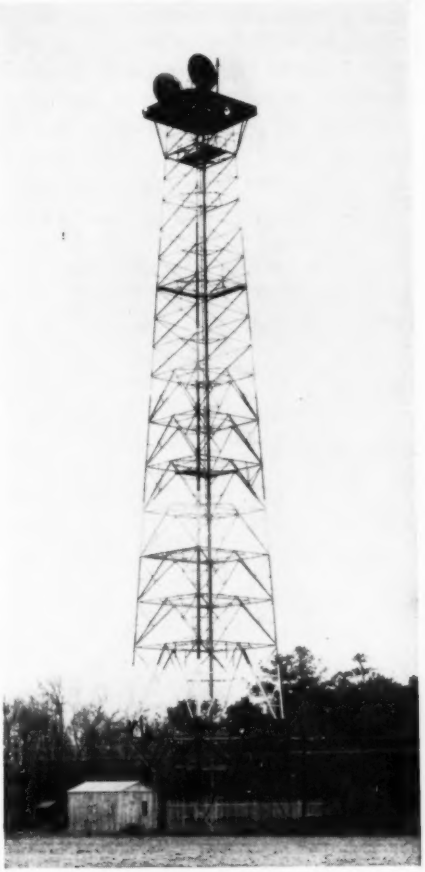
Designing New Structures

RADIO RELAY is a comparatively recent development in long distance telephone and television transmission. Research, tests, and actual experience have modified some of the original ideas about how it should operate, and those changes have been reflected in the building designs.

The first of the long-haul radio relay systems to be placed in service was the New York–Boston system, which

uses equipment of an experimental type. This route starts from the top of the Long Lines headquarters building at 32 Avenue of the Americas, in New York, some 450 feet above sea level. There it jumps to Jackie Jones Mountain, on the edge of Palisades Interstate Park in back of West Haverstraw, N. Y., then to Birch Hill to the north of Brewster, N. Y., and on to five other stations. The last stop is the roof of the New England Telephone and Telegraph Company's Bowdoin Square building, 220 feet above sea level, in Boston. Being located in hilly country, with clear paths between stations, the buildings required for this system did not have to be of any great height—the highest only 52 feet above ground. A review of the equipment to be used indicated that it could be placed in a two-story building about 24 feet square. The design settled on was such a building, having four corner columns and one center column of reinforced concrete, with walls of concrete blocks. The columns were extended above the roof to the height required and a platform was constructed there for the antennas.

The next group of buildings to come under consideration were those for the New York–Philadelphia (Wyndmoor) section of the New York–Chicago route, and for the Chicago–Milwaukee route. It was known that at many locations substantially taller structures than the New York–Boston system would be needed. The engineers thereupon cast about to see if there was any type of commercial structure which might be adapted to the need. Their eyes fell on a tall reinforced-concrete chimney,



A 200-foot steel structure, with the equipment building at its base, near Newtown, Va., is a unit of the Richmond–Norfolk branch radio relay route

and that is what they used at the start: a tall, tapering chimney with five interior floors for equipment, topped off with two antenna platforms.

The use of the chimney structure had its merits at the time, as it involved only small design changes to make it adaptable for radio relay use, and contractors had on hand the nec-

essary erection forms. It did, however, have the objection that goes along with fitting square pegs in round holes: that is, the equipment to be used was designed for straight lines of bays and it was difficult to obtain good floor layouts without wasting space.

WHEN it became evident that radio relay was to become one of the major systems for furnishing long distance facilities, a firm of consulting engineers was engaged to make studies, in coöperation with our own engineers, and to design a type of structure best suited for the job. Many and interesting were the conferences which took place before a design was accepted, since there were advocates of round, square, concrete and steel structures, and combinations of them.

The final decision was the square structure which by now may be familiar through reproduction in both telephone and general periodicals. It combined two requirements: it could not only provide the necessary elevation, to get the antenna horns up to required heights, in increments of about 15 feet, but also it had room within the structure for the equipment. The latter ability was considered essential, as tests had indicated serious transmission impairment under certain conditions if the waveguides (the hollow metal tubes used in place of wires to connect the radio equipment to the antennas) were too long. If the equipment was located on floors placed as desired inside the building, the length of these waveguides could be controlled. The structures, being of reinforced concrete, were extremely stable.

A total of 49 of these structures, of varying height, was erected in 1949 and early 1950, stretching from Philadelphia to Des Moines by the way of Pittsburgh, Cleveland, and Chicago; from Cincinnati to Columbus; from Albany to Syracuse; and from Buffalo to Rochester. This was really a prodigious job.

Some of the buildings were erected by the fixed form method of construction, whereby a form for a certain part of the height—one floor, in this instance—is put in place, the concrete is poured, and time is allowed for it to harden, after which the form is raised for the next higher section, concrete is poured, and so it goes until the top is reached.

The rest of the buildings were erected by the continuous pouring or slip-form method—something like raising oneself by his own boot straps. In this technique, concrete is poured into a form which is raised by jacks, about seven inches an hour in the case of radio relay buildings. Once the job of pouring the concrete is started, it is carried on continuously, day and night, rain or shine, until it is completed. This means that the outside walls of the highest concrete structure built in 1949 were completely poured in two weeks. This does not finish the job, of course, as floors and antenna decks must be poured, stairways erected, and electric wiring installed; but the over-all job really is fast. Most of these buildings were erected in the rural sections of the country, and it did not take long for the word to get around that something interesting was going on. Week-ends, especially, the sites were the mecca of all the surrounding countryside. Whole families would show up and spend hours watching

the work. In the cities they would be called sidewalk superintendents, while out there they were obviously field engineers.

Skeletal steel structures carefully designed to provide the desired rigidity, have been erected for some of the branch route radio relay systems. Some have an equipment room at the top, with a power building near the base, and others have only the antennas mounted at the top, with both equipment and power located in a building at the base. In other cases, where a hurry-up job for a short time has been involved, telephone poles have been used for the antennae supports and construction shanties for the equipment.

For the new radio relay structures required in the latter part of 1950, it is planned to make more use of open steel structures, with the radio and power equipment usually located in a building on the ground. In some cases, however, the radio equipment will be in a room located part way up, with the power equipment on the ground. This change, which studies indicate will save money in building construction, has been found practicable as the result of experience over the past year. Designs have been worked out to obtain structures for general use for heights up to 250 feet in increments of 12½ feet. A design has also been completed for a steel tower more than 400 feet tall which will be erected adjacent to the telephone building in Des Moines, Iowa. In this case, the equipment will be located in a penthouse on the roof of the telephone building.

Locations for buildings for wire communication systems are generally independent of terrain, and definite rules have been made and are followed for the spacing between stations. This is not so for radio relay systems: with them, it is a case of setting them up about as far apart as possible—taking into account both technical considerations and the country along the route. For flat country, assuming the use of struc-

The antennas visible near the top of the left face of the tower of this commercial building in Columbus, O., are 450 feet above the street—much higher than the elevation offered by the roof of the local telephone building

tures about 200 feet high, the spacing might be only 20 miles between stations. If two high mountains could be found on which stations could be placed, with a broad, flat valley between, much wider spacing might be employed. Then again, a very short spacing might be required, perhaps not more than 10 miles, which could be the case when getting into a city over chimneys, and buildings, even though structures as high as practicable were used on the terminal building and at the adjacent station. On the New York–Chicago route, the shortest spacing is 13.1 miles, the longest 38.6 miles, and the average is 24.6 miles.

THIS RADIO RELAY development is changing the appearance of the roofs of the telephone buildings in a number of cities. At one time a roof was just a roof—but not so now if radio relay comes its way. If it is tall enough for the antennas, fine!; they will be mounted on an ordinary platform of sufficient height to clear any roof obstructions. If not, up goes a supporting structure for the antennas, the tallest to date being one 110 feet above the roof. If there is no space on the upper floors for the equipment, a pent-house is built for it on the roof, as has been required in a number of places.

Before construction of radio relay structures is started, certain government regulations must be met. There are rules as to how high a structure may be, in relation to its distance from an airplane landing field or if it is in a flight zone. Also there are rules for installing obstruction lighting under certain conditions and for stripe painting of steel open structures. It is a pleasure to note that the coöperation of and the assistance received from the government representatives in these matters has been of great assistance in expediting the work.

Special Buildings for Long Distance

THE ERECTION of buildings for use exclusively for long distance telephone service is, of course, nothing new in itself. Only the designs, based on the requirements, are new as different types of communication systems are developed.

In the very early days of long distance telephony, test stations were located at different points along the open-wire routes. In a number of cases these were the residences of the section linemen, and the testboard, usually operated by the lineman's wife during the day, was in one of the rooms. Then there were the "Rx" offices, on the outskirts of large cities, where "through" switches were made to avoid the transmission loss through the cables into the toll office in the city. Practically every large city had an "Rx" office in its day; but most of them have long since been given up, since the transmission loss of the toll entrance cables is no longer a matter of moment.

Shortly after the development of the vacuum-tube telephone repeater came the development and rapid expansion of the use of small-gauge wires in cable for long distance transmission. This caused a boom in the building program for the next few years, as stations to house the telephone repeaters required much closer spacings than had been required on the open-wire lines.

Left: In harmony with its residential location, this building serves nevertheless as a voice-frequency repeater and coaxial main station

Right: This typical ranch house in Abilene, Tex., is actually a coaxial main station

Left: The front section of this structure, built in 1917 in Princeton, N. J., was the first building erected primarily for telephone repeaters on 19-gauge toll cable. It now houses voice, K, and coaxial repeaters, and last year was cited by the Garden Club of the State for contributing to the beautification of New Jersey's highways

In the latter part of the '30s, the broad-band carrier systems, known as the Type K system for cable and the Type J system for open wire, were made available. Again the building engineer went busily to work, as the building requirements for these systems were different from anything previously required. The equipment was designed for automatic operation, with attendance required only in case of trouble or for periodic testing and adjustment. Buildings with standardized floor plans to insure economies in engineering and equipment installation were designed. These were fire resistant and included arrangements for temperature control, protection against marauders, and burglar and other alarms. In the next few years some 500 of these buildings were erected, in about every conceivable location from cities to back roads and from vineyards to deserts.

The development of the coaxial cable, on which the Type L broad-band carrier system operates, brought in its train another job for the building engineer. This was the design of

a small intermediate repeater station in which there would be very little temperature variation over a 24-hour period. With the large variations of outside temperature which may occur between the hottest part of the day and the coolest part of the night, maintaining a small temperature range within the structure presented quite a problem, especially as no power would be available to accomplish it by artificial means.

The answer was obtained by "mass construction," using 16-inch concrete block walls, a concrete floor and ceiling, and placing 10 inches of insulation over the ceiling. Before the heat of the sun has had time to penetrate the walls to raise the temperature inside, night cools off the walls, and then the cycle starts all over again. Close to a thousand of these buildings, most of which are about 7 by 10 feet in inside dimensions, are now in operation.

In general, structures for intermediate repeaters for all types of such systems are located in suburban areas, and this has been taken into consideration in designing the buildings and grounds. Where appropriate because of the surroundings, especially in residential areas, the buildings have been designed and the grounds landscaped in keeping with the neighborhood. Proper maintenance of buildings and grounds is the pride of the station personnel. Interestingly enough, the Princeton, N. J., repeater station, which is the oldest of the voice cable repeater stations, was one of 60 commercial and industrial establishments to receive from the Garden Club of that state a 1949 citation for civic achievement for contributing to the beautification of New Jersey's highways.

As compared to the building requirements for intermediate stations, those for the terminals of new types of systems have changed very little over a long period of years. A building that was constructed years ago for, say, manual switchboard equipment would have the proper floor strength and ceiling heights for the newer types of dialing equipment, either local or toll, or could be used for the newer types of long distance telephone systems. The New York No. 4 Toll Switching System, for instance, our largest toll dialing center, and placed in operation in the latter part of 1948, is located on floors which were erected about 1917 for future manual toll switchboard use.

FROM a long distance communication standpoint, the development of the voice frequency cable, broad band carrier, and coaxial cable facilities have improved the quality of the service while reducing the cost to the public over the years. The development of radio relay has presented for certain situations another communications tool; and while experience with it so far is limited, its expectations are high in the minds of those who are working with it. Future developments, whether they be complete new systems, or changes in radio relay or other of the present systems, will no doubt pose many problems of building design and construction. But there seems to be reason, based on past accomplishments, to believe that the building engineer will do his part to produce something better and at the lowest cost which comports with efficient operation.

A Fourth of All Calls, Including More Than Half of the Toll Calls, Begin or End at Switchboards the Telephone Companies Do Not Operate

The PBX Side of Telephone Service

Lewis M. Fuehrer and Glen Whiteman

THE PRIVATE BRANCH EXCHANGES * which are served by the Bell System far exceed in number all the local and toll central offices which serve them.

About 175,000 women are employed to operate these 140,000 private branch exchanges: employed not by the telephone companies but by the customers on whose premises the equipment is installed.

About one fourth of all the telephone calls handled by the Bell System begin or end at private branch exchanges, and more than half of all the toll calls go through these switchboards. And there are, of course, innumerable "internal" calls which go through only the one switchboard.

These calls are a substantial part of Bell System business, obviously; but, as is equally obvious, the operation of the switchboards where they originate or terminate is out of the System's hands. The System can be only indirectly responsible for the quality of that much of the service.

Yet, to the public in general, the Bell System *is* responsible for the quality of all telephone service and not just part of it. The System just cannot avoid it.

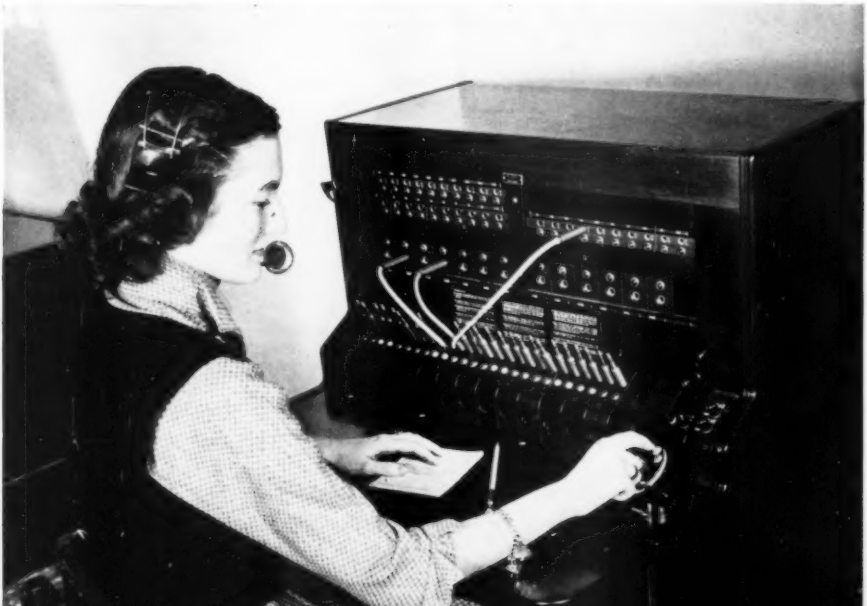
What the System is doing to help keep up to Bell standards that share of its business which it serves but does not control is the subject of this discussion.

* A private branch exchange, commonly abbreviated to PBX, is basically a switchboard installed by the telephone company on a customer's premises to provide interconnection among his several telephones and also between those telephones and most of the telephones in the world via the telephone company central office which serves him.

Equipment and Attendants

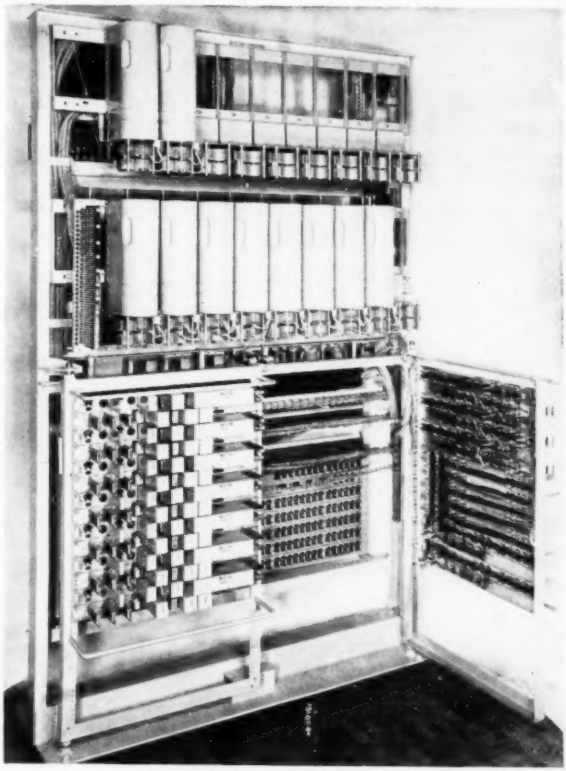
By 1879—the year after the first commercial telephone exchange in the world was established—the first PBX was placed in service. Soon the value of this kind of equipment for providing a fast intercommunicating service for the telephones within an organization was recognized, and the demand for it increased. Through more than 70 years, customers' service requirements have grown more complex, and the design of PBX switchboards has paralleled the development of new types of central-office switchboards with improved operating features. Today, Bell System companies offer their customers, for use on their own premises, various standardized types of cord, cordless, and dial switchboards; miscellaneous facilities, such as conference equipment, code calling equipment, and tie trunks; and equipment, such as order turrets, to meet special requirements.

PBX switchboards need attendants, and telephone companies very quickly found themselves not only furnishing the equipment but helping customers to find attendants—and then training them in its operation. That process still continues. So does the tradition of courteous service which it inculcates. As long ago as 1904, Bulletin No. 11 of the Amer-



A "streamlined" private branch exchange switchboard recently placed in service. The arrangement of cords and keys is more convenient for the attendant, and there is more working space on the shelf in front of her, than in earlier models

ican Telephone and Telegraph Company, "Private Branch Exchange Operating Methods," declared: "In central office operating methods, it is the first requisite in an operating force that the operators be trained to uniform and courteous methods in dealing with the public. This requisite applies with equal force to the operators at a private branch exchange. The requirement that private branch exchange operators shall exercise courtesy in the performance of their duties applies not only to their dealings with their immediate employers, but also to their dealings with the outside public, and with operators at the central offices and at other private branch exchanges. A business house can no more afford to have discourteous operators than it can afford to have discourteous clerks to receive customers."



An "inside" view of recently developed switching equipment for a dial system serving 80 extension telephones

Not only are PBX attendants courteous in the performance of their duties, but they are actuated by the same "spirit of service" as are their sisters at the central-office switchboards, and many have had opportunity to manifest their loyalty and resourcefulness. Private branch exchange attendants do not come within the scope of the Bell System's Vail Medal awards, yet seven medals have been especially voted to PBX attendants for noteworthy acts of public service. Of this number, three were posthumous awards to women who gave their lives that others might live.

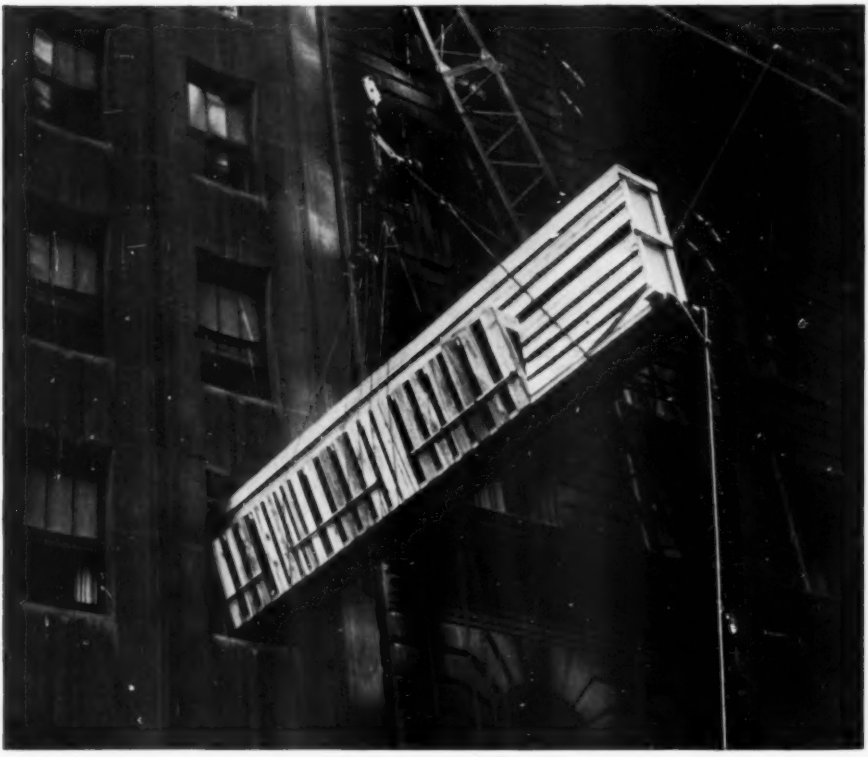
Elements Affecting Service

MANY private branch exchange installations are tailor-made to meet the individual service requirements of a particular customer. Yet, in the design of each system, many factors other than the customer's indi-

vidual service requirements must be taken into consideration.

Every installation is an integral part of the nationwide telephone network, and all the various circuit components are properly designed to be linked with local central office circuits, toll circuits, and circuits to other private branch exchanges in the Bell System. Each board must be properly engineered, installed, administered, and maintained, and uniform operating practices must be prepared, in order to insure efficient and economical operation and to avoid service faults on calls to or from other customers.

The grade of service on every incoming call is affected by the design of equipment and by the service rendered by the attendant in handling the call. When Mrs. Smith, in San Francisco, calls Mr. Smith at his hotel in New York, it is not just by accident that the connection is established even though Mr. Smith is not in his room. Special operating practices for such conditions have been introduced at most hotels; and in this case the private branch exchange attendant,



This 26-foot private branch exchange switchboard, weighing 8250 pounds, is being maneuvered entire through the window of a large bank

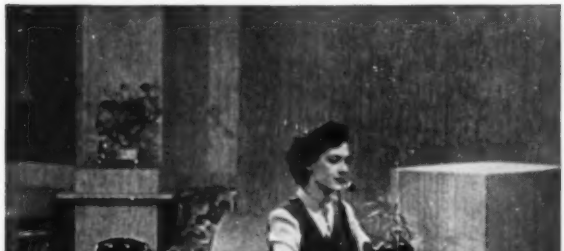
Here is the same 8-position switchboard—shown opposite—in service

upon being told by Mr. Smith that he will be available in the dining room, places a distinctive signal plug in all appearances of his line at the switchboard, indicating where he may be reached and permitting Mrs. Smith's call to be completed promptly.

New types of equipment are constantly being designed, to keep pace with the development and growth of communication requirements and to meet the different service needs of many customers.

A new console type of manual switchboard is now being provided for small installations of one or two positions. Streamlined in appearance and equipped with removable outer casings which may be finished in different colors to harmonize with the interior of the customer's office, it embodies many new operating, equipment, and maintenance features. These include additional bulletin and writing space, improved ringing and talking keys, and automatic grouping of positions for light-hour operation. There are also self-contained cord and trunk units which may easily be added to, removed, or relocated, thus making possible a close adjustment of the equipment to the "load requirements"—number and kinds of calls—without interference to the service.

Two new PBX switchboards have



This "still" is from "The Invisible Receptionist," a motion picture about the work of PBX attendants which was made particularly for showing at group meetings and other suitable occasions

been made available for use at large manual and dial installations. One embodies special operating and service features such as automatically started machine ringing on calls to telephones it serves directly; "audible flashing recall," whereby a single movement of the switch hook to recall the attendant causes the supervisory lamp to flash intermittently and an audible signal to sound until the attendant answers or the caller hangs up; and idle trunk indicating. The other is designed for use at installations where the customer does not require all these features. However, it is arranged for idle trunk indicating, and has an optional arrangement for audible flashing recall.

One package-type dial private branch exchange is new to the service. It is designed to facilitate the engineering and installation of small dial systems and to assist the Associated Companies and the Western Electric Company in providing dial equipment for them. One important feature is that incoming tie trunks from an associated private branch exchange are so arranged that the calling PBX telephone may dial the called telephone without the assistance of an attendant at either location. Another feature provides switches arranged to hunt over a group of lines which serve employees doing the same type of work, in order to permit connection to the next idle line in the group when the line that has been dialed is busy.

The availability of the various sizes and types of systems does not in itself mean that for a given number of telephones a particular type of switchboard is required. Requirements vary considerably, and in some cases the operating characteristics of concerns having the same number of telephones differ so widely that it is necessary to provide twice the amount of switching equipment for one as for the other. A hotel with 3,000 telephones, most of which are in the guest rooms, may require a 20-position manual switchboard, for instance, while an industrial concern with 3,000 telephones may require a 40-position manual switchboard to give the same grade of service. This difference is due primarily to the large number of intercommunicating calls in the large industrial concern and the relatively small number of

calls between guest rooms in the hotel.

SINCE each installation is engineered to meet the individual service requirements of the particular customer, studies must be made of the numerous conditions which affect these requirements before the equipment can be installed. Calling rates, holding times, distribution of intercommunicating, outgoing, incoming, and the various types of tie trunk traffic all have direct bearing on the type, quantity, and arrangement of equipment to be provided. The number of switchboard positions is determined by the amount of time it takes the attendants to handle the traffic which in turn is determined by the number and classes of calls to be handled. It may take twice as long to handle certain outgoing central office calls as it does to handle internal calls completed direct to the station multiple, and still longer to handle certain classes of toll calls.

In most cases, the studies embrace a consideration of both manual and dial private branch exchanges, so that the customer may have the benefit of expert guidance and experience in the selection of equipment which is best suited to meet his service requirement. Floor plan layout, lighting, ventilation, operating room appearance—in fact, most of the factors involved in engineering a new

This group of private switchboard attendants is meeting with telephone company Service Advisers to discuss service matters of mutual interest

central office—are taken into consideration.

Many customers have separate private branch exchanges in two or more locations which are interconnected by means of tie trunks between them. The advantage of direct connection between distant points of an organization was realized early in the telephone industry. When the Brooklyn Bridge was being built, the following item appeared in one of the local newspapers: "A Bell telephone has been put in operation between the office of J. Lloyd Haigh, of 81 John Street, and his steelworks in South Brooklyn where the wire for the great cables is being made. The wire passes through Buttermilk Channel and across the East River and is about five miles long. Conversation is carried on with ease . . ."

Today, one of the largest steel companies, with numerous private branch exchanges in 29 different cities in 10 states, is provided with hundreds of miles of Bell telephone facilities, not only for interconnecting the private branch exchanges within each city but also for connecting together those in key cities in different states and different Associated Companies.

Another example of large size and elaborate engineering of PBX facilities is found in the interdepartmental dial switching system which serves

These PBX attendants (left), visiting a telephone company central office, discuss service matters with the chief operator

A "social hour" concludes a visit of PBX attendants to the telephone company, and conduces to pleasant acquaintanceship among women with a common interest

various Government agencies in Washington. It includes more than 3000 switches and 2900 tie trunks and interconnects more than a hundred separate private branch exchanges. This installation handles from 115,000 to 120,000 calls in the course of an average business day—and that is more calls than are handled in that period in some fair-sized cities.

Toward Good PBX Service

THE PBX SWITCHBOARD has been called the nerve center of the modern business organization. In many organizations, practically all of its telephone communications involve private branch exchange facilities; and from the standpoint of the customer, the installation of the proper type and quantity of equipment is just the beginning. One of his most important problems is the hiring and training of regular and relief attendants for handling the calls that pass through the switchboard. Bulletin No. 11, already mentioned, also suggested that the telephone companies employ experienced supervisors to visit regularly the private branch exchange switchboards and give the attendants such assistance as they may require. Today there are nearly 800 Traffic Department employees assigned to visiting, training, instructional observing, and placement work. During the past year, more than 320,000 visits were made by PBX Service Advisers, as they are now called; and on about half these visits, executives

of the customer organization as well as PBX attendants were interviewed.

There is, of course, close coördination among the several departments of the telephone companies in carrying on the various phases of the PBX job, and to the interviews of the Traffic Department's Service Advisers can be added an equally large number of interviews which the Commercial Department's sales and servicing specialists hold with the PBX customers themselves.

In the larger cities, Bell telephone companies maintain training departments where instruction in PBX operating is given to new attendants. These are preferably people already employed by the customer, for such people are already familiar with the establishment and find less difficulty in completing calls to individuals and departments. In the smaller cities, the training is usually done by the Service Adviser at the switchboards that the attendants will operate. About 35,000 attendants were trained last year.

This work with the attendants is effectively supplemented by a program of Commercial's servicing forces to promote good telephone usage and habits among PBX telephone users.

Attendants call on their ServiceAdvisers for assistance in perfecting their operating technique and in meeting the many different problems encountered in giving a personalized service at their switchboards. Their work is in many ways more complex than that of the central office operator, for they are often required to give many services of a somewhat secretarial nature.

Each problem is individual in itself. For example, an extension user may request the attendant to place all toll calls for him, and hang up after giving his order. Of course, this practice is a carry-over from earlier days when a recording operator in the toll office took the details of the call and advised the calling party that he would be called back when the connection was ready. With today's toll service, and particularly with operator toll dialing, the extension user who remains on the line will be talking to the called party in a minute or less on most calls.

ONE CONDITION which Service Advisers not infrequently encounter at small PBX switchboards is the assignment to the attendant of other duties which inevitably interfere with her primary responsibility of handling telephone calls. An incoming call left unanswered while the attendant is busy at the files or—believe it or not!—delivering the mail, may of course mean a disgruntled buyer who takes his order elsewhere.

Some establishments require rather elaborate records of calls, in order to bill them to departments or individual extension users.

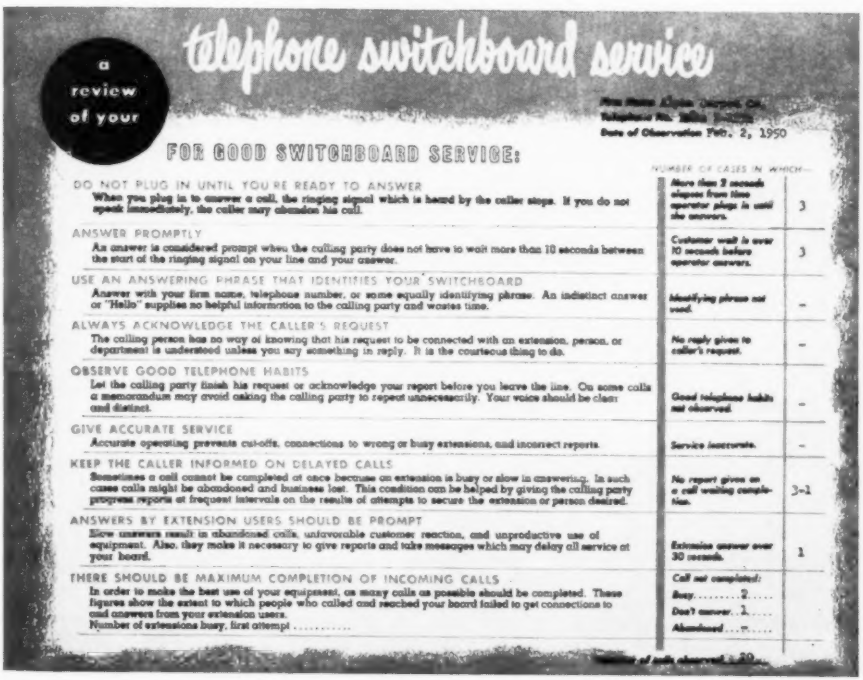
Many demands are made upon the attendants by their extension users in the way of following up calls where the called party is out or where the call is intercepted by a secretary who waits to put her supervisor on the line until she learns who is calling and what about.

The attendants at many switchboards also handle numerous calls from outside parties regarding information of a general nature. This is particularly true at switchboards which serve governmental agencies

and those which serve newspapers and public utilities. Some newspapers maintain special information departments to which questions are referred.

The Service Adviser from the telephone company is often able to assist a PBX attendant in other than technical operating matters. She can, for example, bring to the attention of an executive of the customer's organization, either directly or through the Commercial servicing representative, certain problems which lower the quality of telephone service and which the attendant alone is unable to correct. Such things as slow answers by extension users, and extensions which are in use an inordinate percentage of the time, are beyond an attendant's control, but can often be corrected without difficulty when their adverse effect upon his service is pointed out to the customer. The customer—often as represented by some official or executive of the firm —is usually not only cooperative, but grateful to the Service Adviser or other representative of the telephone company for the interest shown in improving his service.

An occasional additional duty of the Service Adviser is to supervise the collection of traffic data which summarize the extent to which PBX equipment is being used. Various types of calls, and conditions which affect operating work time and circuit



a review of your

telephone switchboard service

Date of Observation Feb. 2, 1950

FOR GOOD SWITCHBOARD SERVICE:

	NUMBER OF CASES IN WHICH—	
DO NOT PLUG IN UNTIL YOU'RE READY TO ANSWER When you plug in to answer a call, the ringing signal which is heard by the caller stops. If you do not speak immediately, the caller may abandon his call.	More than 2 seconds elapse from time operator plugs in until she answers.	3
ANSWER PROMPTLY An answer is considered prompt when the calling party does not have to wait more than 10 seconds between the start of the ringing signal on your line and your answer.	Customer wait is over 10 seconds before operator answers.	3
USE AN ANSWERING PHRASE THAT IDENTIFIES YOUR SWITCHBOARD Answer with your firm name, telephone number, or some equally identifying phrase. An indistinct answer or "Hello" supplies no helpful information to the calling party and wastes time.	Identifying phrase not used.	–
ALWAYS ACKNOWLEDGE THE CALLER'S REQUEST The calling person has no way of knowing that his request to be connected with an extension, person, or department is understood unless you say something in reply. It is the courteous thing to do.	No reply given to caller's request.	–
OBSERVE GOOD TELEPHONE HABITS Let the calling party finish his request or acknowledge your report before you leave the line. On some calls a memorandum may avoid asking the calling party to repeat unnecessarily. Your voice should be clear and distinct.	Good telephone habits not observed.	–
GIVE ACCURATE SERVICE Accurate operating prevents cut-offs, connections to wrong or busy extensions, and incorrect reports.	Service inaccurate.	–
KEEP THE CALLER INFORMED ON DELAYED CALLS Sometimes a call cannot be completed at once because an extension is busy or slow in answering. In such cases calls might be abandoned and business lost. This condition can be helped by giving the calling party progress reports at frequent intervals on the results of attempts to secure the extension or person desired.	No report given on a call waiting completion.	3-1
ANSWERS BY EXTENSION USERS SHOULD BE PROMPT Slow answers result in abandoned calls, unfavorable customer reaction, and unproductive use of equipment. Also, they make it necessary to give reports and take messages which may delay all service at your board.	Extension answer over 30 seconds.	1
THERE SHOULD BE MAXIMUM COMPLETION OF INCOMING CALLS In order to make the best use of your equipment, as many calls as possible should be completed. These figures show the extent to which people who called and reached your board failed to get connections to and answers from your extension users. Number of extensions busy, first attempt	Call not completed: Busy..... 2..... Don't answer.. 1..... Abandoned.... 1.....	

Analyses of customer PBX service are made at their request, and are summarized in such fashion for the guidance of attendants and Service Advisers

DON'T LEAVE THE CUSTOMER IN THE DARK
ACKNOWLEDGE EVERY ORDER
PLEASING SERVICE PS-21
VOICEWAYS
wishes you a Merry Christmas and a Happy New Year
CORD SWITCHBOARD SERVICE
PBX Notes
OPERATE TALKING KEY before PLUGGING IN
He may hang up if you're not ready to answer when you plug in. Then you BOTH lose!
Good PBX Service builds good will

PBX practices, service notes, personnel publications, and reminder cards are among the items distributed to attendants to help them to give good service

holding time, are encountered at PBX switchboards, and accurate information is important to the telephone company engineer in planning facilities for growth or for the installation of some new type of equipment.

Invited Guests of the Telephone Company

PBX ASSISTANCE is a two-way street: the telephone companies' Service Advisers visit the PBX attendants at their switchboards, and the attendants likewise visit the telephone companies. Meetings of attendants on telephone company premises are a regular part of company PBX programs.

Typically, a group of attendants is welcomed by a Traffic Department representative who is concerned with their work, and a general discussion of problems of common interest is held under company leadership. A conducted visit may be made to local or toll switchboards or other equipment. Perhaps a Bell System motion picture—"The Invisible Receptionist," for instance—is shown. There is likely to be a social hour after the business in hand is completed, and probably some simple refreshments.

By the time the guests are ready to leave, they have accomplished several things. Those who had problems in connection with their jobs may have received the solution—or at any rate have heard some helpful discussion and perhaps sound advice. They have formed pleasant contacts with fellow workers in the same field of endeavor. They may have met some of the telephone company operators who handle the calls they originated at their PBX switchboards, and established an *esprit de corps* with them. They take away with them, it seems likely, a "lift" from the realization that they play an essential part, with the Bell System, in helping to provide a nation-wide service of the first importance.

That this isn't phantasy—or wishful thinking—is attested by the numbers present at such meetings. Of the attendants invited to an evening meeting, on their own time, 75 percent are likely to show up—and some of the rest will ask to be included another time. To such meetings held during business hours, customers are likely to arrange to send their PBX attendants with their blessing.

THE TELEPHONE COMPANIES of the Bell System supply PBX switchboards and equipment to their customers at tariff rates. They could let it go at that. Instead, they go to great pains to see that those customers enjoy good service.

Helping customers to find attendants, and then training them, assisting them to solve their service problems, stimulating their sense of accomplishment—all this is an extensive and important activity for which no charge is made. But it keeps the service standards high throughout this country and assures that these customers get the utmost in effectiveness from their equipment.

The Educational Objective of the Telezonia "Package"

Arthur C. Stenius

Dr. Stenius is Professor of Education and Director of the Audio-Visual Materials Consultation Bureau of Wayne University, Detroit, and served as consultant to the A. T. & T. Co. during the research, production, and classroom testing of the "package" comprising the Telezonia project. EDITOR.

CHILDREN learn more when such instructional materials as films are used in the classroom. This fact is no longer news. The lack of suitable materials, however, still forces many teachers to fall back on less effective methods and sources of instruction.

The importance of the telephone in the life of a youngster has been realized for many years. But up to now, the individual teacher had to develop her own material for teaching the "how" of getting children to understand the importance of good telephone habits and gain skill in them.

This is why the motion picture and supplementary teaching aids recently developed by the Bell System are so significant. Whether a teacher wants to motivate pupils in the study of telephone usage, to impart information, or to develop skills, suitable materials are now available for her use.

Moreover, classroom try-outs of these materials have assured us in the teaching field of their effectiveness as instructional devices. Their value is the result of the careful testing that was done at each stage of their development—from the decision to produce a motion picture through to the classroom activities suggested in the material itself.

The entire package has been planned for classroom use. What would serve teachers best has at all times been the controlling factor. The results of this policy are evident in the materials. They will serve well the teachers of the nation. For no longer will teachers be handicapped in instructing in the use of the telephone by lack of effective materials. We as educators hope that the way the Bell System has gone about producing these instructional aids may be of use to other institutions anxious to help the schools in preparing youngsters for living in our modern, complex world.

XUM

A "Package" of Materials for Instructing Grade-School Children in Good Telephone Usage Has Been Prepared Under Professional Guidance to Meet Classroom Needs

Adventure in Telezonia

LeRoy A. Born

TELEZONIA? What is that—and where?

It is a new and fanciful land, inhabited by gnomes, where castles look like telephones, tree trunks look like cables, buds like insulators, and even the flowers remind one of mouthpieces. It is the land where school children may now go to learn about the telephone and how to use it. The journey there is via a motion picture, with the same title as this article, just made available by the Bell System as a part of a "package" of teaching materials for elementary schools.

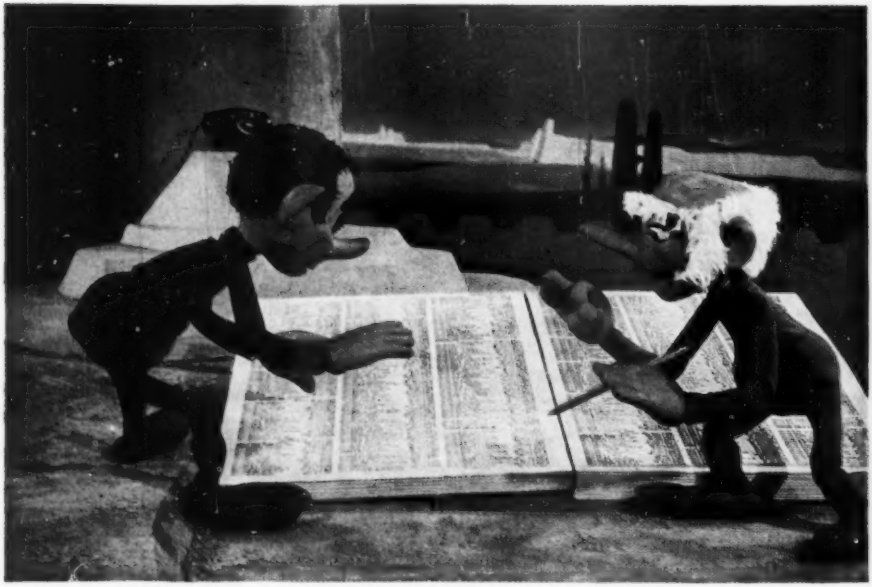
Preparation of this package is the outcome of many requests from school people for instructional material on the use of the telephone. The need was confirmed through research conducted at the request of the Bell System by a leading authority in the field of "audio-visual" education.

Besides the motion picture, the components consist of a silent filmstrip, a children's booklet, and a teacher's instructional guide. In addition, the Bell telephone companies are making available a pair of telephone instruments, and local directories, for classroom practice.

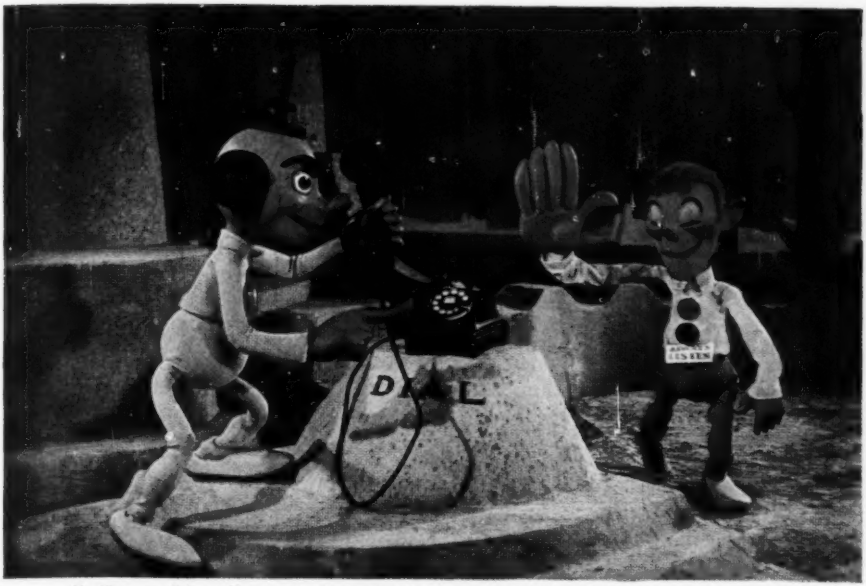
The child of today is as familiar with the telephone as are his parents. By the time he is old enough to enter school, he is rushing to answer it. The telephone habits which twenty-odd million American school children are forming today will become more fixed as they grow into adulthood. Establishing good telephone habits now, before indifferent ones become ingrained, would be of incalculable benefit to the service and to its present and future users. Teachers have said that instruction in good telephone usage is as important in preparing the child for modern life as the etiquette of writing letters.

Teaching children how to conduct themselves—over the telephone or in any other situation—is, of course, the business of parent and school. But every so often, educators have come to the Bell companies for authorita-

Bobby's friend "Handy" introduces him to the Mayor of Telezonia



"Ready" makes sure of the right number before making a call



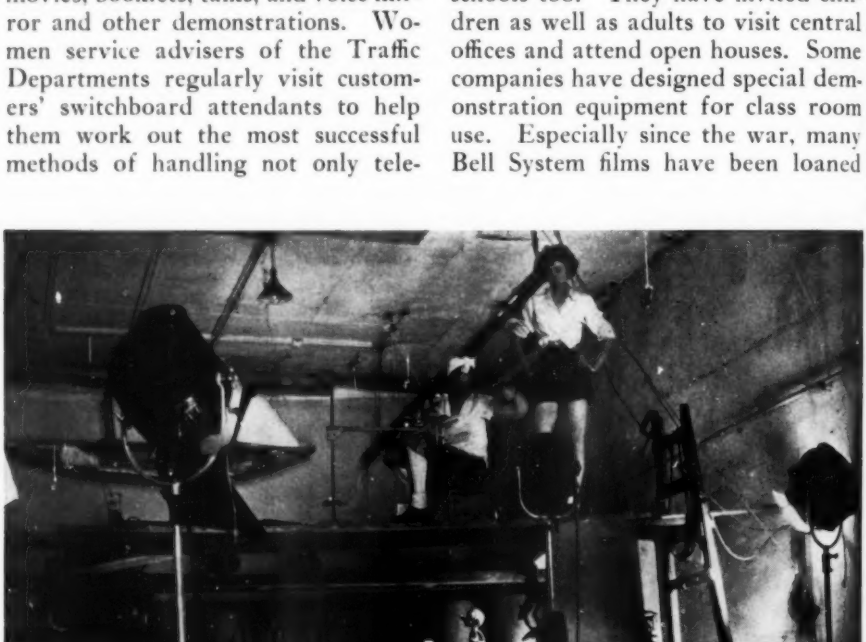
"Always Listen" emphasizes the importance of listening for the dial tone

The Mayor reproves "Mumble-Voice" for his failure to speak pleasantly and clearly

tive material to help them do the teaching job. The companies have responded gladly with what has been available.

The Bell System has long recognized its obligation, in the interest of the best possible service, to help people use the telephone to their own and the community's best advantage. For years, good telephoning practices have been presented to adult groups in many ways: among others, through movies, booklets, talks, and voice mirror and other demonstrations. Women service advisers of the Traffic Departments regularly visit customers' switchboard attendants to help them work out the most successful methods of handling not only telephone calls but telephone callers. Commercial Department representatives and service engineers aid customers in selecting the most suitable service for their needs and in making the most effective use of it. These departments in their own fields undertake a variety of activities to improve telephone operation and use among both business and residence customers.

They have done much for the schools too. They have invited children as well as adults to visit central offices and attend open houses. Some companies have designed special demonstration equipment for class room use. Especially since the war, many Bell System films have been loaned



Setting the stage for a scene of the motion picture. The marionettes are manipulated from a scaffold above the set

to schools which have asked for them either individually or for deposit in educational film libraries.

But, useful as these efforts have been, it is nevertheless the hard fact that most of the informative material available to schools had been prepared primarily for adult consumption.

Smoothing down the plastic wood head of a marionette

THE SUCCESS of films and demonstration materials in military instruction during World War II has given a new impetus to the use of these so-called audio-visual aids not only in industry but in the schools as well. Major school systems now have audio-visual departments, and several educational publications specialize in this field. Continuing demand for telephone films and other material is indicative of their usefulness to schools. But, since they were made for use with adult audiences, their treatment makes them less adaptable to the elementary grades, and school people were beginning to ask for films more closely geared to the childhood level.

The decision to honor these requests was not as simple as it might appear on the surface. School authorities guard zealously against attempts to use the classroom for ulterior purposes. In common with American industry generally, the Bell System has respected this attitude, recognizing its importance in a free society. Only on rare occasions have we sought permission to enter the schools, and then only when the requirements of the public service, such as during cut-overs from manual to dial service, suggested it.

On the other hand, many educators have felt the need for first-hand information about the complex industrial world which they are preparing the child to face. "Where can we go," they have asked, "for authentic teaching materials about industry—except to industry itself?"

If this point of view—at least as applied to the telephone industry—were as widespread as the post-war straws in the wind appeared to indicate, it would seem to be simply a matter of good citizenship for the

Bell System to give all reasonable assistance to the schools.

In considering the production of the films and other aids that the teachers were asking us for, we started from the premise that there must be unmistakable assurance that any such materials would be acceptable throughout the educational world. They would have to be wholly in tune with the policies and teaching methods of the schools. There must be nothing in them that was not dictated by the school curriculum. So, while the benefit to the telephone companies must be proportionate to what they spend for the project, this benefit must of course be secondary to the purposes of the schools.

Seeking Professional Counsel

EARLY in 1948, the Bell System sought the advice and assistance of the Audio-Visual Materials Consultation Bureau of Wayne University, at Detroit, Mich. The Bureau itself had been formed for the purpose of helping industry in preparing materials for school use. For the Bell System, the Bureau first made a preliminary study of the curricula of forty typical school systems, to find

The reaction of third graders to "Adventure in Telezonia." This flashlight picture was snapped during a showing in a Michigan public school

out to what extent and at what grade levels the subject of communications is taught.

This was followed by a more intensive survey in the form of a questionnaire addressed to more than 1800 elementary public school principals throughout the United States. In essence, the questions were:

(1) Would a motion picture on good telephone usage be of value to teachers?

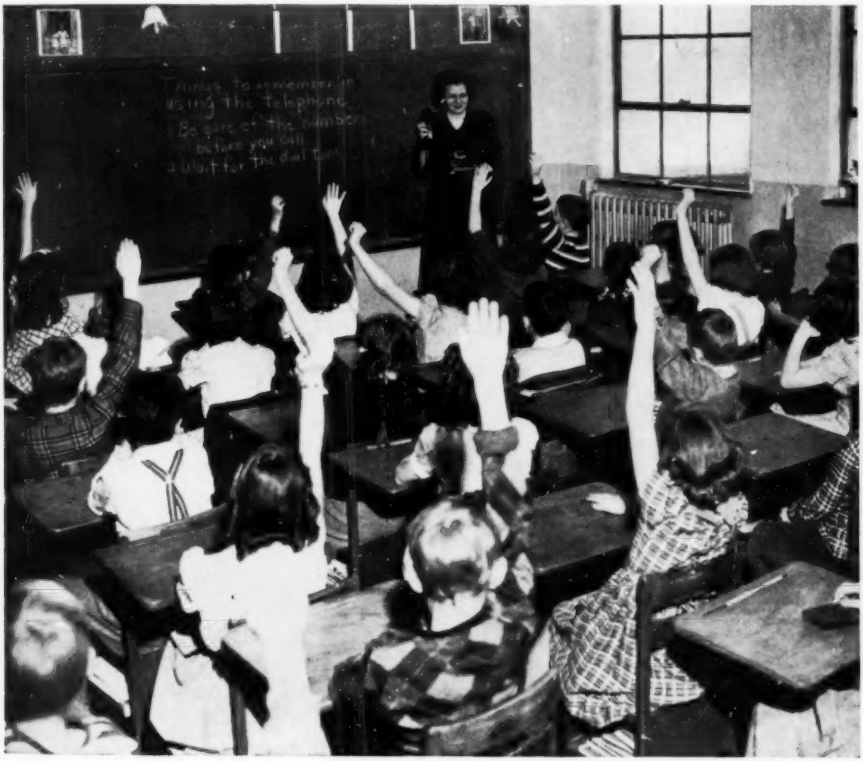
(2) If so, should it be sponsored by the Bell Telephone Companies and loaned free to the schools?

(3) What supplementary aids, if any, would be desirable?

(4) To what grade levels should the material be directed?

In addition, mail inquiries and personal interviews were conducted among a score of key persons in the audio-visual and elementary-school fields.

The replies to the questionnaire ran well over fifty percent—an abnormally high figure, according to the Bureau. Even more significant, ninety-seven percent of the replies to the first two questions were an unqualified *yes*. There was only one un-



A teacher discusses good telephone usage with third grade puspils

The teacher helps a pupil to become accustomed to the correct way to hold the telephone

qualified *no*. The qualifications expressed by the remaining few concerned the conditions of making the material available rather than the question of sponsorship as such.

To quote the Bureau's report: "Such unanimity of opinion from a national sampling of educators is phenomenal. It is doubtful that any such high percentage of agreement would be possible even on the most fundamental principles of learning."

As to grade level, the replies generally confirmed the Bureau's curriculum study. The greatest use for the film would be between the third and sixth grades, among children between the ages of eight and eleven.

The reason lies in modern educational methods. The subjects once known as geography and history are now approached by starting with the child's own environment. In the first grade, he learns to understand his place in his family and immediate neighborhood. This is broadened in the second grade to a further understanding of the life of the whole community. It is usually in the third year that he is introduced into the way the community uses its means of transportation and communication. It is into this "social studies" approach that material on the use of the telephone needs to fit to be most useful.

The replies to the questionnaire also showed a heavy demand for supplementary aids to the motion picture. Schools vary widely in their use of audio-visual materials. Of the 200,000 or more elementary public schools in the United States, nobody seems to know how many are equipped with facilities for showing films. Estimates range from twenty to fifty thousand and up. Schools with and without motion picture projectors make heavy use of filmstrips, which are merely a series of still pictures on a roll of 35 mm. film. These are screened from a motorless projector which is small, portable, and easy to operate.

For schools without a projector of any kind, a printed text, such as a booklet, can be useful for teaching good telephone usage. Even where a projector is available, a booklet would permit covering the subject in fuller detail through follow-up teaching and individual study.

For young children at least—and who would not say for adults as well?—the final and most important step

is guided trial and practice until effort yields to habit. As walking is learned by walking and talking by talking, so talking properly into a telephone becomes natural only after the user becomes familiar with the feel of it. "At the present time," the Wayne Bureau reported, "toy telephones brought to school by the children are almost universal aids to teaching this unit of work." What better way is there to practice the use of the telephone than by having a real telephone and directory to use?

To cover adequately the needs disclosed by its research, the Bureau suggested a "package" of materials, so designed that each item could be used either independently or in conjunction with any of the others, as the teacher might desire or school facilities permit. With the survey results giving so unequivocal an answer, what to do but go ahead?

It was well that the Bureau had been first consulted, for its research had made clear the need for expert advice, to insure furnishing schools what they themselves wanted in the form they could use most successfully. The Bureau was retained, therefore, as educational adviser throughout the undertaking.

The "package" of teaching materials becomes one literally when packed in a stout carton like this

At Bell System headquarters, in New York, the Commercial and Traffic Divisions of the O. and E. Department and the Information Department worked together in drawing up an outline of the picture's teaching content. Particular stress was placed on points most pertinent to children. These included such matters as the importance of being sure of the right number through proper use of the directory; correct dialing, including listening for dial tone; what the dial tone, the ringing, and the busy signals sound like; how to give a telephone number to the operator; and, above all, how to speak clearly and courteously over the telephone—with special emphasis on party-line neighborliness.

This information was given to a scriptwriter, Mrs. Ruth Snow Burns, experienced in film-writing for children. It was also used as a basis for the script of the filmstrip prepared by the Wayne Bureau, and for the children's booklet and teacher's guide produced by the Bell System.

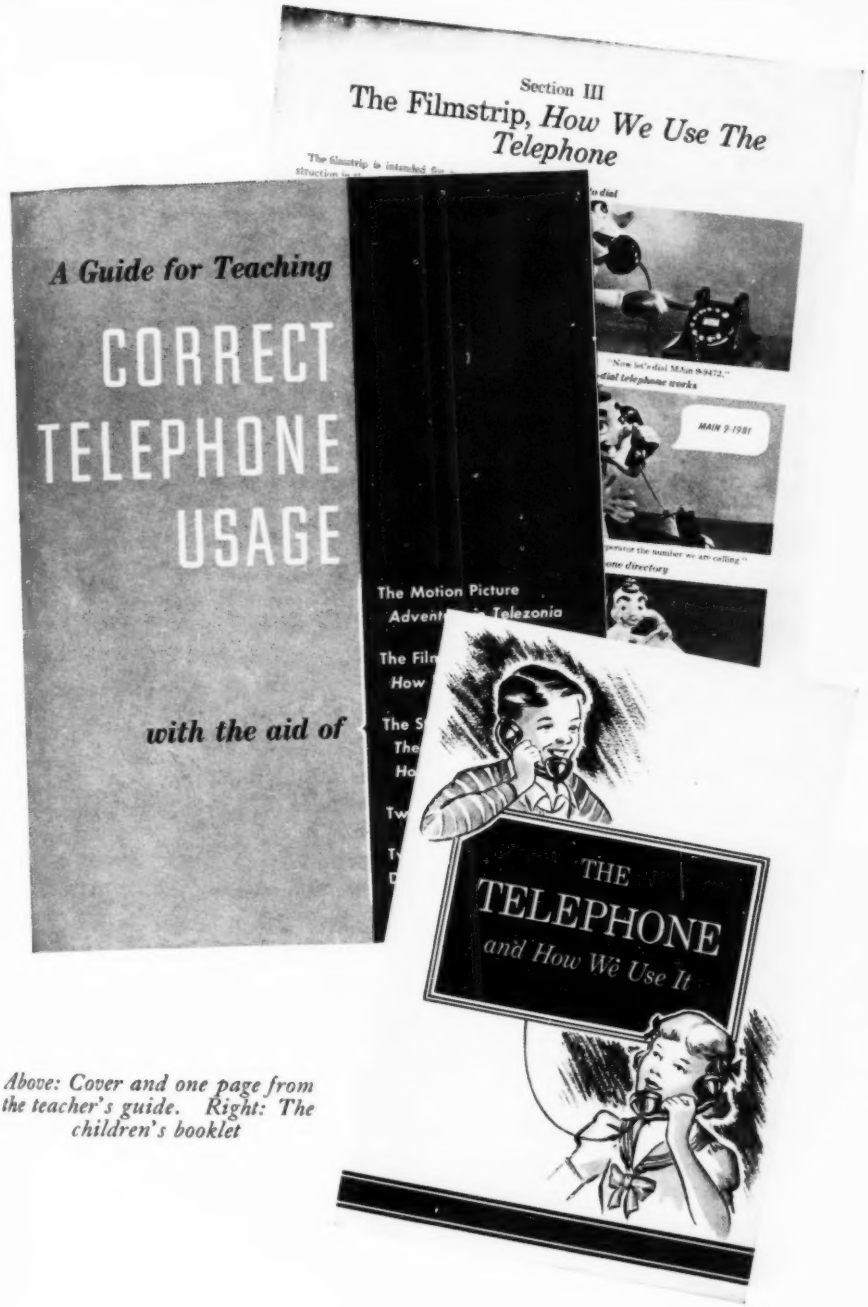
A Boy and his Dog

TELLING the motion picture story through marionettes—with their perennial appeal to all ages—was a "natural." Bil Baird, who had made the previous Bell System marionette film, "Party Lines," was engaged as producer.

The motion picture, in 16 mm. color and running 18 minutes, took shape as the story of Bobby, a boy who loses his dog Bounce. In his excitement, Bobby fails to use the telephone correctly and attracts the attention of a gnome, Handy, who offers to help. Bobby is transported to Telezonia, where the gnome inhabitants help him find his dog through correct and courteous use of the telephone.

Handy himself, with receivers for ears and antenna for a hat, assembles the citizens as the Mayor, wearing an insulator as his cap of office, keeps a fatherly eye on the proceedings. As each gnome takes his turn in trying to locate Bounce, Handy points out to Bobby what is right or wrong about their use of the telephone. There is the energetic and efficient Ready, expert in the use of either dial or non-dial telephones. His friend, Always Listen, appears at dial telephones to remind us to listen for the dial tone. An elderly, meticulous directory gnome looks up telephone numbers with the gravest of care to get the right one. The indistinct speech and bad manners of Mumble Voice defeat his eagerness to help until the Mayor intervenes. And there is the little girl gnome who is always polite to others on her party line, despite her distress when her attempt to find Bounce is delayed by long-winded Party Line Piggy. The final call that locates Bounce is made successfully by Bobby himself.

The filmstrip, "How We Use the Telephone," with fifty-two pictures in color, uses some of Telezonia's characters, but is not a still version of the motion picture. It is a teaching medium—and an important one—in its own right. One of its advantages is that it lends itself readily to class participation. For example, a close-up of a dial with the captioned question, "How would you dial SOuth 9–9076?" encourages the child to step to the screen and demonstrate to the class. Another picture asks,



Above: Cover and one page from the teacher's guide. Right: The children's booklet

"Which one of these girls is holding the telephone correctly?" for the class to volunteer the answer. In this way, and point by point, it illustrates each of the principles of good telephone usage.

The children's booklet, "The Telephone and How We Use It," explains the use of the telephone and directory in greater detail and with profuse illustrations. The back pages are devoted to a series of classroom exercises, with a sheet on which the child may early establish the habit of keeping his own personal telephone number list.

The teacher's manual, "A Guide for Teaching Correct Telephone Usage," deals separately with the use of all the materials in the "package" to achieve fullest teaching effectiveness. It contains, in addition, some general background information about the telephone, and a bibliography of reference material.

Pre-test Results

BEFORE the cameras were to turn, it was decided to pre-test the material, to make sure that content, vocabulary, and pace were suitable to the third-grade level. Drafts of the scripts, booklet, and guide were distributed for comment by the Wayne Bureau among a hundred or more teachers and audio-visual experts. The motion picture script was recorded on a disc and rough drawings of each scene were put on a strip of film. These, along with drafts of the children's booklet, were taken to a number of classrooms and teachers' groups in the Detroit area. While still in this rough form, it was clear that the children liked the story and understood its message. Even third graders could read and understand the booklet.

Meanwhile, at the Baird studio, in New York City, the sets were being built for the imaginary land of Telezonia. The heads of the marionettes were fashioned at first in clay, from which plaster casts were made. Into these was poured the plastic wood of the final product. For Handy alone, four separate heads had to be designed, each with a different expression and mood. Movable eyes, brows, and chins were slipped into place and wired to the manipulating strings. Hands were carved from wood, each with a different gesture.

A good part of 1949 was spent on all phases of production. From the scaffold above the studio stage, the Bairds pranced their puppets to the camera's rolling tune. Stills were photographed for the filmstrip. The booklet and guide approached their final form.

As soon as first copies of the material were ready, the complete product underwent the same testing as the first drafts, in about a dozen classrooms and in several teachers' groups. Bell System Commercial and Public Relations people attended some of the tests, observed the children's intense concentration on the puppets of the screen, and listened to their answers to the teachers' questions.

There was no doubt that these children—whether of the third or the sixth or even the eighth grade—enjoyed the experience and remembered what they had seen. Teachers were asked, therefore, whether enjoyment

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of the story might overshadow its teaching value. The unanimous opinion was that the one served only to enhance the other.

It was equally evident that the package would fulfill these teachers' needs. Several commented that it would be useful, beyond its immediate purpose, for teaching such unrelated subjects as spelling, vocabulary, English composition—and even drawing, for which the marionettes could serve as models.

THE PACKAGE was released early in 1950 to the Bell companies, which are announcing it and making it available to schools. Since this is a new venture, many unusual and challenging problems of distribution need to be overcome. Procedures vary among school systems for putting instructional materials into the hands of teachers. Plans are already being made to work out with school authorities the most effective and economical means for distributing the material to all schools that may want it—including those in the territory of non-Bell telephone companies.

Some two million children in American elementary schools pass through one grade each year. The great majority of them are not only tomorrow's telephone users but today's. It is too early to predict how many school children will take the journey to Telezonia, or the influence it will have. The degree of its success rests with its acceptability to the schools, and their experience with it. It is hoped that some schools will be interested in using measurement techniques to find out whether, what, and how much children learn and retain of its message.

At any rate, the venture of "Adventure in Telezonia" will bear watching for the sake of the future telephone habits of America. For it is today's young Americans who will be the chief beneficiaries of a more pleasing and more valuable telephone service, to whose improvement they themselves will have contributed an important share.

This Magazine on Microfilm

AN AGREEMENT has been entered into between the American Telephone and Telegraph Company and University Microfilms to make the BELL TELEPHONE MAGAZINE available in microfilm form. Microfilm makes it possible to produce and distribute an entire volume of a periodical on a single roll of film. The microfilm is on positive film, and is furnished on metal reels, suitably labeled. Inquiries concerning microfilms of the BELL TELEPHONE MAGAZINE should be addressed to University Microfilms, 313 N. First Street, Ann Arbor, Mich.

A Better Plan for Christmas Traffic

Lowell F. Wingert

ANOTHER CHAPTER can be added now to the article by Cyril K. Collins entitled "Merry Christmas in the Toll Offices" which appeared in the Spring issue of this Magazine a year ago. It concerns a new plan used last Christmas, following a satisfactory trial on Mother's Day, in a further effort to complete the greatest possible number of holiday calls with facilities which cannot be expanded sufficiently to absorb the enormously increased volume of long-haul switched calls offered on this one day of the year.

Completion of calls was improved an average of about five percent in the System, with Long Lines messages as much as 14 percent higher in 15 representative cities. Fewer delays were posted, and those of five hours or more were reduced about 30 percent from a year ago. Credit also is due to other factors, such as a slight reduction in volume together with a small increase in circuits, a fine performance by the No. 4 operator toll dialing equipment, and improved operating experience. These, and a new practice, contributed to the most satisfactory handling of Christmas traffic in a number of years.

The Traffic Department describes the new practice as the "circuit division plan," and it was designed to "divide and complete"—to paraphrase the familiar military axiom of "divide and conquer." Its primary purpose is to relieve the congestion occurring in the largest switching centers in the System.

Fifteen of these cities—New York, Chicago, St. Louis, Atlanta, Pittsburgh, Detroit, Minneapolis, Denver, Omaha, Dallas, Cleveland, Boston, Kansas City, Newark, and Washington, D. C.—were selected by the Operating Companies as the primary switching centers needing the most relief. Under the division plan, these were designated as "Group A" cities. Twenty-six smaller cities, known as secondary switching centers, and all Pacific Company cities with transcontinental circuits to eastern terminals, were known as "Group B" cities.

All circuit groups between "A" offices and those between "A" and "B" offices were divided directionally on a 50–50 basis. For example, if there were 10 circuits between two of these cities, they were divided so that each had five for their own exclusive use. Any odd circuits were given to the office appearing first in an alphabetical list.

All other cities in the System, however—and this is the significant factor—divided their circuit groups with "Group A" cities on a ⅔–⅓ basis, with the "A" switching center using the larger portion. Such a division

has the effect of holding back the traffic, to some extent, at originating offices instead of allowing it to pyramid at the large switching centers. At the same time, by providing additional circuits—two-thirds of a group—for the completion of through calls in "Group A" cities, more calls could be switched through these centers without delay—thereby reducing to a considerable extent the usual Christmas "bottleneck."

In addition to the primary advantage of a reduction in delays at the switching centers, several other important advantages were achieved with the plan. Traffic forces generally reported that the circuit division eliminated much waste circuit time ordinarily caused by operators challenging each other for the use of circuits. This practice, only rarely required under normal operating conditions, is effective, but it is time consuming and wasteful under extreme holiday overloads. Also, any considerable amount of challenging for circuits adds noise and confusion to an operating room. Chief operators commented that much quieter and more efficient operating conditions were experienced than on previous Christmas days.

Of considerable importance was the added advantage that the circuit plan utilized normal every-day operating practices, thus eliminating the need of training thousands of operators in special holiday methods, with an attendant loss of operating efficiency.

Instructions concerning all groups to be divided were furnished to those concerned by November 15, thereby allowing adequate time for preparation. Actual divisions were made not later than 4 P.M. on December 24 in all offices, in order to be ready for the Christmas Eve rush. In most cases, circuits were divided without the necessity of a telephone call between the terminal offices affected. Considering the large number of circuits which were divided, and the numerous offices in the plan, the division was remarkably effective. The Plant forces played an important part in handling the equipment phases of the division, and the Commercial Department assisted greatly in the arrangements made with the independent companies which participated in the plan.

Aggressive efforts are being made to find still better methods for handling the Christmas traffic peak. Two modifications in operating practices, which it is hoped will result in still more effective use of circuit time are being tried on this Mother's Day.

1. Reduce the interval of time which circuits may be held at the second switching office or beyond, when no-circuit conditions are encountered.
2. Extend the time interval before leaving an order for a circuit at the first switching office when a no-circuit condition is encountered. During this additional period, operators at the originating offices will make additional attempts in an effort to complete these calls.

It is hoped the results of these trials will turn out to be helpful material for another chapter in the continuing story of Christmas service improvement.

Twenty-five Years Ago in the BELL TELEPHONE QUARTERLY

Items from Volume IV, Number 2, April 1925

The Recent Solar Eclipse

WHEN the eclipse of the sun swept down from Lake Superior toward New York City on January 24, 1925, and then out across the Atlantic, many engineers of the Bell System were at specially assigned posts within and near the path of totality to note any anomalous behavior of radio waves or of grounded telegraph lines. At the request of the American Astronomical Society, the American Telephone and Telegraph Company, through the Long Lines Department and through the Bell Telephone Laboratories, loaned facilities to assist in obtaining scientific information regarding the eclipse, the present eclipse having been unique in that it passed over territory exceptionally well provided with communication facilities. The use of long distance telephone and telegraph circuits enabled the observing astronomers to time more accurately both the eclipse and their photographing of certain details, such as the flash spectrum.

Progress in Telephotography

ON APRIL 4, 1925, the American Telephone and Telegraph Company inaugurated a limited service for the transmission of pictures over long distance circuits between New York, Chicago, and San Francisco, following three successful demonstrations during the preceding month of the method developed by Bell System engineers.

The first of these demonstrations was held March 1, when three test pictures were transmitted from Washington, D. C., simultaneously to New York, Chicago and San Francisco, and there distributed to the press. The second was on March 4, when nine news pictures of the Inauguration of President Coolidge were transmitted to New York, Chicago and San Francisco. The third was on March 19, when, without previous preparation, a dozen good news pictures of tornado damage in Illinois and Indiana, offered by various pictorial news services, were sent from Chicago to New York and San Francisco.

The first picture of the Inauguration of President Coolidge, that of the floral tribute to Mrs. Coolidge presented by ladies of California, was started on the circuit from Washington at 10:22 a.m., Eastern standard time. Extra editions of newspapers carrying this picture were on sale in San Francisco before 11 a.m., Pacific standard time, and in Chicago at about the same time. In all, nine official pictures, including one of the administration of the oath, taken from a distance of about 125 feet, were transmitted up to 5:45 p.m. From 25 to 40 prints of each picture were made at New York and Chicago and about 100 of each at San Francisco and furnished to newspapers and others for reproduction. Practically all the principal daily papers in the three receiving cities used the pictures, in some cases several being used on a display page. In some instances, enlargements to four and five newspaper columns in width were made and printed with good results.

Noticeable improvement in the quality of the photographs transmitted is noted as a result of several months of continued experimentation and refinement since the initial demonstrations in 1924. Comments of many representatives of the press were to the effect that the pictures now being trans-

mitted are commercially satisfactory and that the system now being offered for commercial use in New York, Chicago, and San Francisco is a practical solution of the problem of rapid and dependable telephotography.

Breaking New Ground

From the A. T. & T. Annual Report for 1949

TELEPHONE SERVICE today is generally as fast, clear, accurate and dependable as at any time in history and the Bell System is breaking new ground in service betterment.

It is fundamental in the policy of the business that the only good service in the long run is one that is always improving. We expect to go forward in the years ahead as we have in the years gone by. Bell System research was never more effective than it is today. Bell System manufacturing, supply and service operations were never better performed. The men and women of all departments are doing a magnificent job and the facilities they design, build and operate are far and away the best in history and getting better every day.

We are confident too that telephone users desire good and improving service and prefer to pay what it reasonably costs. We believe the public understands the need for good telephone wages and working conditions—for a sound financial structure—and for earnings that will continue to provide a steady and reasonable return on the billions of dollars invested in the Bell System by hundreds of thousands of men and women. We have confidence that under wise regulation, in future as in the past, the System will continue to have the means and the freedom it needs to do the best job that it can.

Those are cornerstones in the building of a communication system that is a great national asset. The character of the organization is in its full acceptance of the responsibilities entrusted to it. It is in the knowledge and skill that the Bell System has gained and is constantly increasing. It is in the desire of telephone people to serve with friendliness and courtesy and cheerful will to get the message through. All of these things are as real as the ring of the telephone bell. They are found alike in "the voice with the smile"—in the mind and hands of the craftsman—and in the consideration of every problem of policy. They mean that the Bell System can be relied on to move steadily forward in providing better and better telephone service to the American people.

Who's Who & What's What

(*Continued from page 3*)

the engineering and field tests of just about all types of carrier systems, the toll office terminals of local dial systems, and inter-toll dialing systems. He has been Engineer of Equipment and Buildings of the Long Lines Department since 1943, and has had supervision of the design and engineering of the buildings for broad band carrier projects and radio relay. Along with that has gone the engineering of equipment installations associated with those undertakings and for the operator toll dialing program.

THERE ARE MANY little-known aspects of the widely ramified telephone business, and one of them is the extensive part which the Bell System plays in "PBX" service. LEWIS M. FUEHRER and GLEN WHITEMAN combine in describing certain engineering and personnel activities which are basic to a successful program.

Mr. Fuehrer began his telephone career in New York in 1921, when he joined the Department of Operation and Engineering of the A. T. & T. Company. For five years he was engaged in handling traffic engineering problems relating to various types of central office switchboards. In 1926 he transferred to the Southern Bell Telephone and Telegraph Company, where for two years he worked on inter-office trunking arrangements for local and toll switchboards. He returned to A. T. & T. in 1928, and has since been busy designing more efficient PBX and order turret facilities and preparing standard traffic engineering practices for uniform System-wide application.

Mr. Whiteman began his Bell System career with the Southwestern Bell Telephone Company in 1910, and held traffic assignments there and with the Long Lines Department and the New York Telephone Company before joining the traffic results section of A. T. & T. Company's O. & E. Department in 1922. For the past 20 years he has had to do chiefly with activities which help PBX customers in the operation of their switchboards. During World War II, an important customer was Uncle Sam, and Mr. Whiteman spent several busy years assisting the Associated Companies in organizing and operating PBX service at Army camps throughout the country. Hence came his "Operating Army Switchboards" in this MAGAZINE for June 1943.

LeRoy A. Born

Lowell F. Wingert

LEROY A. BORN began his Bell System career as a contract agent with the New York Telephone Company in Syracuse in 1922. Subsequent experience included commercial and sales training and sales and servicing work. In 1944 he transferred to the Information Department of the A. T. & T. Company, where he is engaged in film and display work. Here he has guided and coördinated all phases of the "Adventure in Telezonia" project. His interest in the educational value of motion pictures is understandable in the light of a youthful two years' experience as a teacher in a "little red school house," a B.S. degree in education *summa cum laude*, and membership in two honorary educational societies.

THE CHRISTMAS traffic situation, one of the most stubborn operating problems in the Bell System, is yielding to patient study and intensive effort, and LOWELL F. WINGERT supplements Cyril K. Collins' "Merry Christmas in the Toll Offices" of a year ago with a briefer report of improvements achieved. Joining the Northwestern Bell Telephone Company in 1934, Mr. Wingert transferred to the Long Lines Department in Chicago ten years later, and subsequently served as force adjustment supervisor in New York and as district traffic superintendent in Memphis. In 1948 he returned to New York to become a member of the Traffic division of the O. & E. Department of the American Company, and was assigned to force adjustment matters. For the past year he has been head of a group handling toll and teletypewriter service results.

What It Means To Be *Telephone* People

WE TELEPHONE PEOPLE travel an unusual road.

In a nation where big business and little business drive down a fast, competitive highway, we have been leased a private way. To us the people of the nation have singularly granted a trust and a power.

In the Bell System there are more than half a million of us, serving twenty-five million customers. On our shoulders alone is the responsibility to give these people the round-the-clock, dependable telephone service they need. In our hands is a power to bind them together in friendship, trust, and common understanding.

Over our switchboards go their hopes, their fears, their sorrows, their needs. Across our lines they order groceries from the corner store, close business deals, make appointments, send tidings of births and deaths. With our help they summon doctors when they're sick, policemen and firemen when they're in trouble. We have taken part in the shaping of the law, the progress of commerce, the growth of schools, and the courtship and marriage of two generations.

Since the birth of the industry, telephone men and women have dedicated themselves to the fulfillment of this—our public trust. They have developed within themselves and the telephone team a spirit of service and helpfulness that has surmounted fire, flood, and disaster. They have handed down to us a heritage rich with their courage, their

loyalty, and their devotion in rendering a service to the people.

We, the telephone people of today, are vested with the responsibility of carrying on this trust. We will make mistakes, for it is human to err. But in the long run, how we do our individual job, how we bear our individual responsibility, will determine how we achieve our trust. For in the last analysis we do not work for the telephone company. We *are* the telephone company.

—*Adapted from a leaflet distributed to its employees by the New England Telephone and Telegraph Company.*

The Bell System Tax Bill

TAXES on Bell System telephone service in 1949 amounted to nearly $800,000,000. This is about $100,000,000 more than the 1948 tax bill and is equal to more than $2 a month for every telephone in service.

Federal excise taxes paid by customers in 1949, and remitted by the Bell Companies to the United States Treasury, came to about $445,000,000. Taxes imposed on the Companies (but also paid by customers in the final analysis) were $346,144,000. In connection with increases in telephone rates, it may be noted that for each $1.00 in additional net revenues, the Companies must charge telephone customers $1.61 to offset the additional Federal net income tax, which is at the rate of 38 per cent. In addition, the customer pays a minimum of 15 per cent for excise taxes, or 24 cents more for a total of $1.85. Of this, the Government receives 85 cents and the Company $1.00.

The present high excise tax rates are a carry-over of wartime restrictions and have no place in the peacetime economy. They discriminate against users of telephone service, as they saddle on them too great a portion of the total tax load. We therefore believe they should be abolished as soon as possible. If they cannot be abolished completely, the first step should be to eliminate the taxes on local telephone service and on toll messages of less than 50 cents, and to reduce greatly the tax rate on other toll messages.

From the A. T. & T. Annual Report for 1949

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